



Effin'Art
The Art of
Energy
Efficiency

Refroidissement évaporatif centralisé pour la rénovation de logements sociaux en Inde

Pierre Jaboyedoff

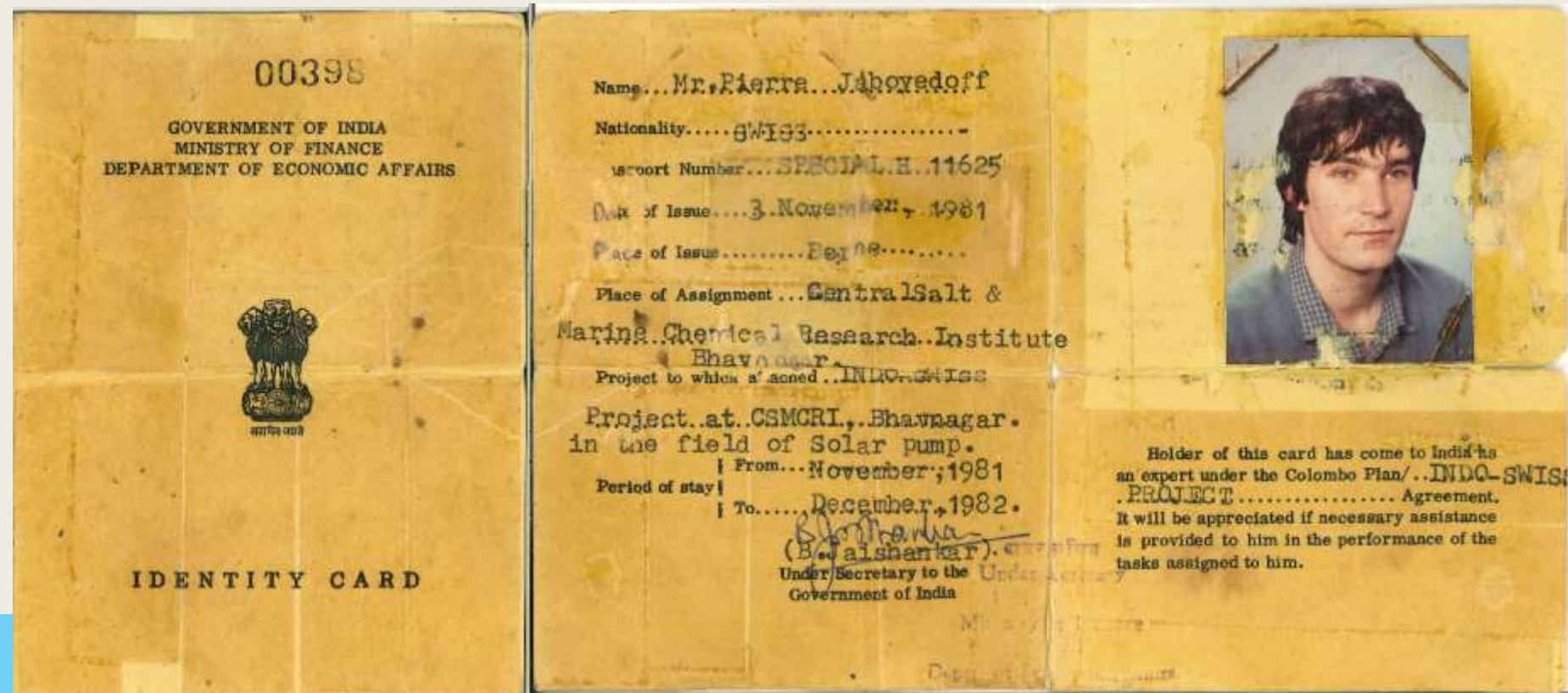
(Effin'Art)

Jeudi 15 octobre

India, an old story



- 1981-1983 Posted in Bhavnagar, Gujarat, in CSMCRI (Central Salt and Marine Chemicals Research Institute), development of a thermal solar irrigation pump (SDC-India collaboration)

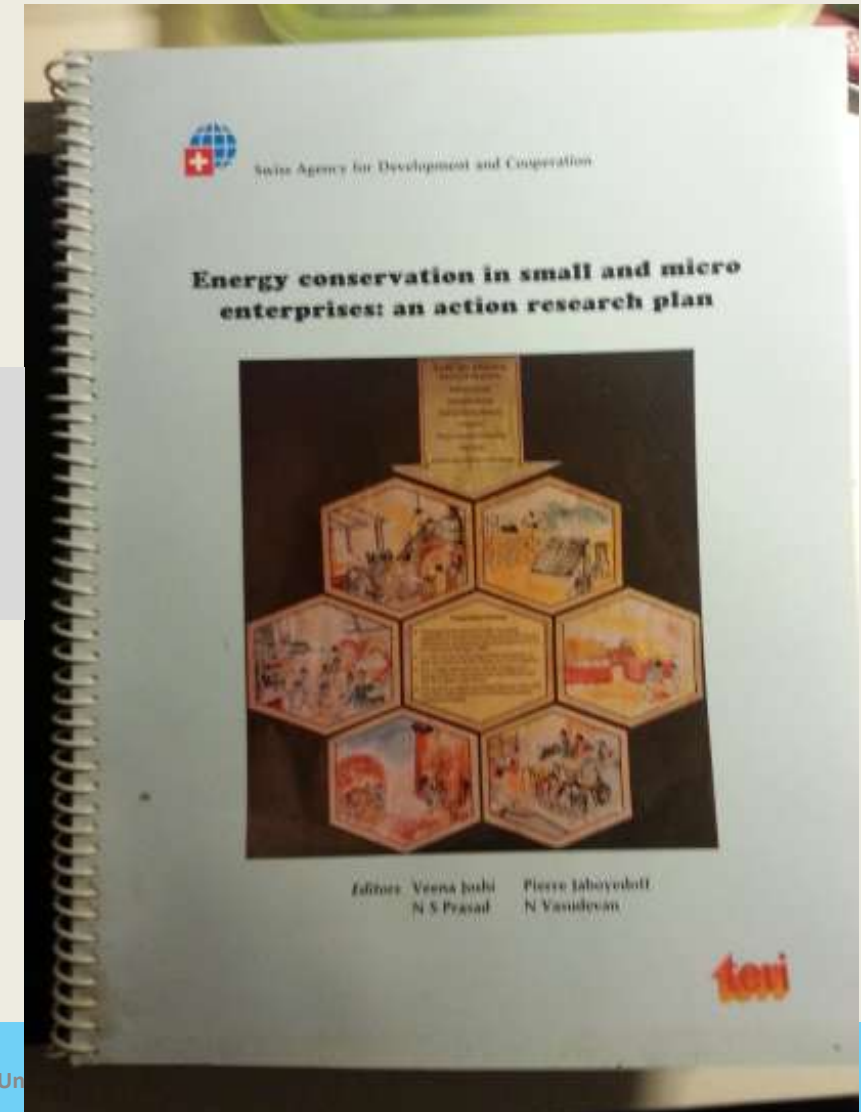


Later



- Study, concept and development of the energy programme of SDC in India
- Organisation of a workshop in 1994
- Launching of the programme in 1995
 - Foundry
 - Glass (Firozabad)
 - Bricks
 - Biomass gasification
 - Thermal applications
 - Rural electrification
- Involved until ~2007 as “backstopper” in all components
- Selection, recruiting and managing specialised consultants

GEOSER : STOCKAGE SOLAIRE A COURT TERME EN SERRES HORTICOLES
Pierre Hollmuller, and ... CUEPE



Indo-Swiss Building Energy Efficiency Project (BEEP) 2008-2023 (webinar on 30 of September)



Indo-Swiss collaboration

National level:  

MoU between FDFA and Ministry of Power/Bureau of Energy Efficiency

BEEP project level: Main partners: Effin'art (CH) and Greentech (IND)

Institutional level:

Swiss Institutions: EPFL, EMPA, HES-SO, University of Geneva, Infras

Indian institutions: Universities, Builders/developers, City municipal corporations, Centre for Media Studies, Administrative Staff College of India



Indo-Swiss Building Energy Efficiency Project (BEEP)

2008-2023, CHF 14 Mio.

Presented by: Anand Shukla

Project deep dive:
Indo-Swiss
Programme on
Building Energy
Efficiency (BEEP)

Anand Shukla

Programme Manager BEEP,
SDC



Building Design Technical Support to Builders: Constructed projects, examples



Aranya Bhawan, Jaipur

31% Energy Savings
Potential to become a Net-Zero Building



Ela Green School, Chennai



Jupiter Hospital, Pune

16% Energy Savings



IIIDEM (Election
Commission
Institute) New Delhi

29% Energy Savings

Smart Ghar III,
Rajkot

Reduction of $>5^{\circ}\text{C}$ room
temperature on a peak
summer day

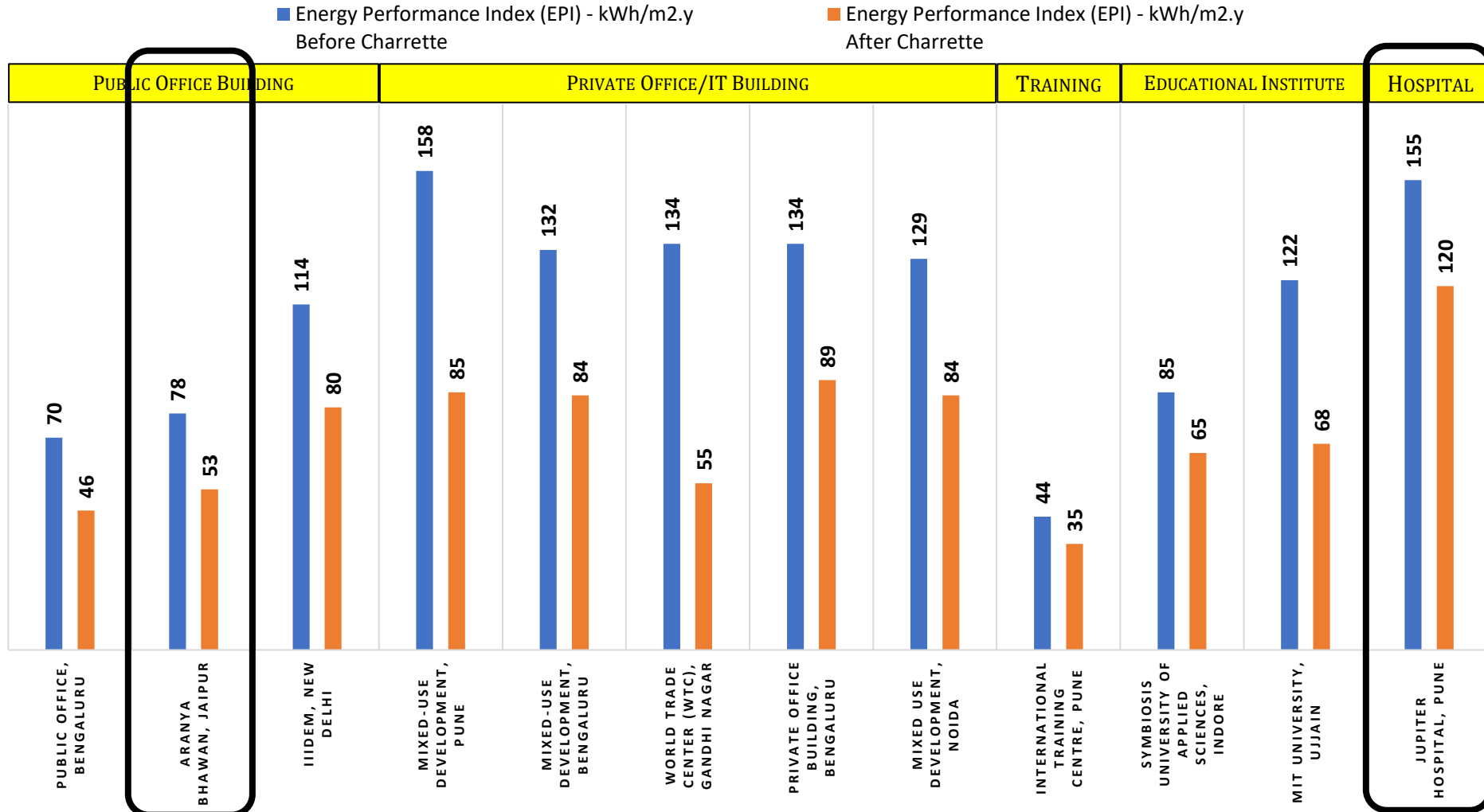




EPI of BEEP Charrette Projects: Commercial Buildings



ESTIMATED ENERGY PERFORMANCE INDEXES OF CHARRETTE PROJECTS



22 design charrettes, ~ 2 millions m² of projects



Real monitored data foster interest of readers (not many in Asia)



CASE STUDY OF AN ENERGY EFFICIENT COMMERCIAL BUILDING: VALIDATING DESIGN INTENT & ENERGY SIMULATION RESULTS WITH MONITORED PERFORMANCE DATA

December 2017

Conference: International Symposium to Promote Innovation & Research in Energy Efficiency 2017, November 27th to December 1st, Jaipur, India · At: Jaipur

Sameer Maithel · Prashant Bhanware · Pierre Jaboyedoff · [Show all 5 authors](#) · Saswati Chetia

Research Interest Score ————— 43.7
Citations ————— 6
Recommendations ————— 3
Reads ⓘ ————— 13,493

[Learn about stats on ResearchGate](#)

ENERGY EFFICIENCY IN HVAC SYSTEM: CASE STUDY OF A HOSPITAL BUILDING COMPARING PREDICTED AND ACTUAL PERFORMANCE AND SHOWING IMPROVEMENTS THROUGH PERFORMANCE MONITORING

February 2020

Conference: ENERGISE 2020: ENERGY INNOVATION FOR A SUSTAINABLE ECONOMY · At: Hyderabad, India

Prashant Bhanware · Pierre Jaboyedoff · Shirish Deshpande · Neelesh Shinde

Research Interest Score ————— 34.7
Citations ————— 4
Recommendations ————— 1
Reads ⓘ ————— 8,475

[Learn about stats on ResearchGate](#)

ECO Niwas Samhita (ENS) 2018



ENERGY CONSERVATION
BUILDING CODE FOR
RESIDENTIAL BUILDINGS 2017
PART I: BUILDING ENVELOPE



ECO Niwas Samhita was launched on 14 December 2018 on the occasion of National Energy Conservation Day 2018

- For “**Residential buildings**” $\geq 500\text{m}^2$ and “**Residential part of Mixed-land use building projects**” $\geq 500\text{m}^2$
- Minimum performance standards for residential building envelope to limit heat gains and heat loss
- Provisions include
 - Maximum **residential envelope transmittance value (RETV)** for building envelope except roof for all climate
 - Maximum **thermal transmittance value (U_{cold})** for building envelope except roof for cold climate
 - Maximum **thermal transmittance value (U_{roof})** for building envelope for all climate
 - Minimum **openable window-to-floor area ratio (WFR_{op})**
 - Minimum **visible light transmittance (VLT)** for non-opaque building envelope components



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Building Policy: BEEP and reduction of heat gains, India 1st standard on building envelope for residential buildings

- BEEP has been leading the development of the building energy codes Eco Niwas Samhita ECBC-R (for residential buildings) and is actively working in the states with the government to promote the adoption.
- More than 40000 EnergyPlus simulation to derive a multi-linear regression method for a simple equation base calculation
- The code has been published by the Bureau of energy efficiency of the Ministry of Power, India. Ref: https://www.beeindia.gov.in/sites/default/files/ECBC_BOOK_Web.pdf
- BEEP has been conducting since 2018 its flagship educational initiative of BEEP camp for engineers and architecture students (masters) and young professionals with selected faculty members.
- Book on heat transfer for under graduate engineering students(part of IIT Bhilai curricula) has been developed



Development Team

Indo-Swiss Building Energy Efficiency Project

Pierre Jaboyedoff, Effin'art Sarl

Sameer Maithel, Greentech Knowledge Solutions Pvt. Ltd

Prashant Bhanware, Greentech Knowledge Solutions Pvt. Ltd

Saswati Chetia, Greentech Knowledge Solutions Pvt. Ltd

Eco Niwas Samhita: India's Energy Code for Homes

The residential energy code that quietly makes homes cooler and cheaper to run — what Eco Niwas Samhita requires, the RETV envelope metric, roof and window limits, natural ventilation and daylight, and why designing the cooling load down is the whole point.

11 MAY 2020 | AMDH N P | 22 JULY 2020 | LAST VERIFIED JULY 2020

BUREAU OF ENERGY EFFICIENCY (BEE)
(Ministry of Power, Government of India)
Website: www.beeindia.gov.in

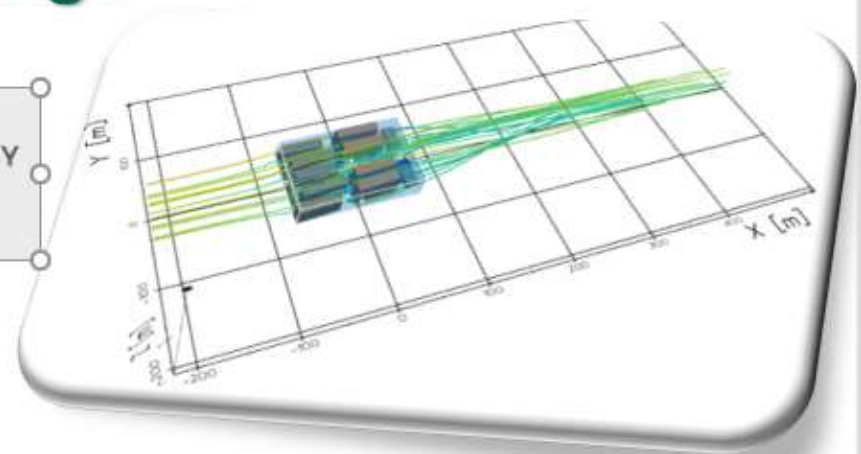
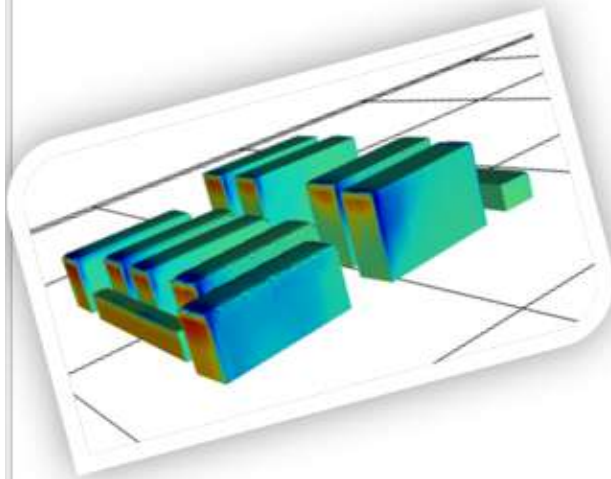




Building Design: Development of a free CFD tool



Development of a freely distributable CFD tool for approximate and detailed simulations of the flow around a complex of buildings



J. Decaix* (HES-SO), P. Jaboyedoff (Effinart), G. Duthé (ETHZ), E. El Sergany (EPFL Master Student), L. Aiulfi (ESRI)

CISBAT 2021 – Lausanne, Switzerland Carbon Neutral Cities - Energy Efficiency & Renewables in the Digital Era
EPFL, 8-10 September 2021

*jean.decaix@hevs.ch



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Other things in India: Hilti energy design and operation Energise 2025 conference

- Very efficient HVAC system
- 2-3 times lower energy for HVAC than known data in Asia
- «high» temperature cooling (fan activated chilled beams) sensible cooling water supply at 20°C
- High performance chillers
- Etc ...



Energy efficient building and HVAC industrial site at Vadodara (HILTI Group)
Ankit Srivastava¹, Gernot Schubert², Pierre Jaboyedoff³

- ¹Hilti, Vadodara, India
- ²Hilti, Schaan, Liechtenstein
- ³Effin' Art, Crissier, Switzerland



extrapolation (12/7) for a yr	7'660	1'263	16.5%
EUI	466	77 kWh/yr m2	

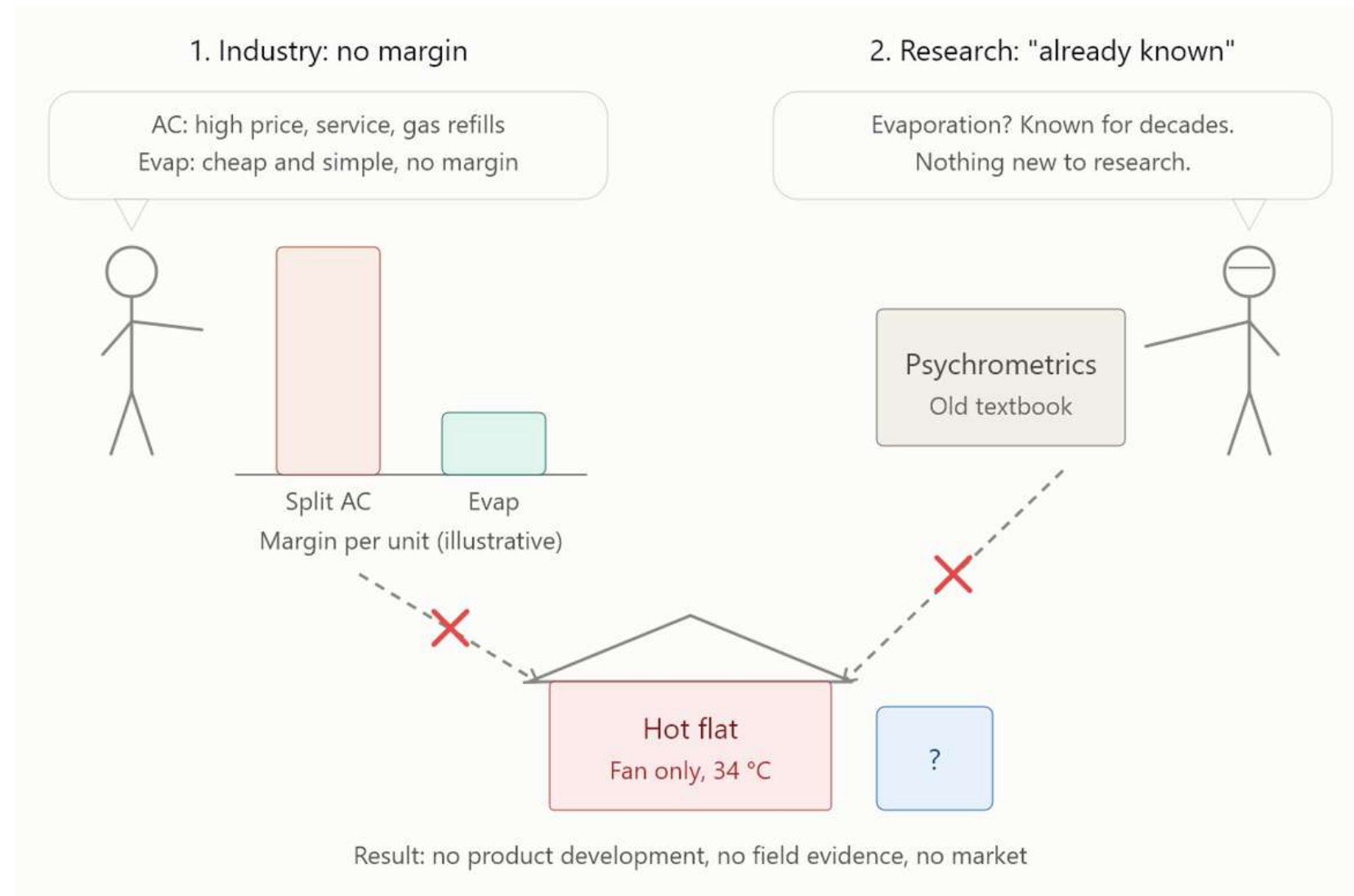


Refroidissement évaporatif centralisé pour la rénovation de logements sociaux en Inde pourquoi ?

- Number of deaths due to heat waves was grossly undercounted and is also actually growing
- Equipment
 - Only ~10 % of flats equipped with active AC cooling
 - The poorest section do have less than 5% AC
 - About 15% have a desert cooler
 - Ceiling fans are in almost all dwellings except some rural areas
- Emergency
 - Time scale of improving buildings
 - Improving buildings envelope, etc . Takes time (decades ?) and does not solve the cooling need for very high temperatures
 - Centralised evaporative cooling can be installed much faster
- Lack of vision for short term actions
- Mitigation
 - Evaporative cooling require less power than Air Conditioning
- Adaptation
 - The time scale for reduction of actual UHS (Uncompensable Heat Stress) is too long with building envelope retrofit etc ..

Refroidissement évaporatif centralisé pour la rénovation de logements sociaux en Inde pourquoi pas ?

- Pourquoi un tel concept et initiative en Inde
- Analyse simpliste
 - Les fabricants d'air conditionnés ne voient pas un marché intéressant
 - Les scientifiques estiment que c'est connu, donc pas d'intérêt



Evaporative Cooling system for extreme heat wave reducing the increasing death numbers in the hot and dry areas of India

- With the new trend of regular heatwaves which can last for 5-7 days, at very high temperature (48-50°C), the number of deaths due to these heat waves, is increasing.
- Many buildings including newly built are not well designed to protect the inhabitants who very often do not have air conditioning.
- **The improvement of building envelope will take time. (difference between the new and retrofit approach)**
- It is urgent to develop and make available for the people a low energy affordable evaporative cooling system (community level)
- Some ideas have been tested in real, but due to COVID could not be tested fully. The idea is to demonstrate the application of such systems with developer/manufacturers rapidly to offer one or more affordable kit **as it is urgent**
- → in discussion with BeCool UNEP to find a demo and decided with Gram Vikas to demonstrate on their new building (two stage solution to cope with the climate there)
- Strategies for slums have not been explored in India (officially it does not exist anymore ...)
- Project ongoing with Gram Vikas in Odisha for an auditorium
- **Can be used also for centralized night cooling**



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6/27/25, 5:51 PM

Undercounted and overlooked: The hidden toll of heat waves on health | The Indian Express

Increasing number of deaths due to heat waves, but very large discrepancy in estimation of deaths due to heat waves

- Beyond Strokes: How dangerous is extreme heat? see <https://energy.prayaspune.org/our-work/article-and-blog/how-dangerous-is-extreme-heat>
- Is India Ready for a Warming World? How Heat Resilience Measures Are Being Implemented for 11% of India's Urban Population in Some of Its Most At-Risk Cities (see <https://www.sustainablefutures.org/publication/is-india-ready-for-a-warming-world-how-heat-resilience-measures-are-being-implemented-for-11-of-indias-urban-population-in-some-of-its-most-at-risk-cities/>)



EXPRESS OPINION

BECAUSE THE TRUTH INVOLVES US ALL

EDITORIALS

COLUMNS

Undercounted and overlooked: The hidden toll of heat waves on health

6/27/25, 5:51 PM

Undercounted and overlooked: The hidden toll of heat waves on health | The Indian Express

Jun 18, 2025 14:08 IST ▾

First published on: Jun 18, 2025 at 13:59 IST

Written by Ritu Parchure and Aditya Chuneekar

As India reels under a scorching summer, the rising mercury is exacting a toll far greater than official figures suggest. For example, in 2019, extreme heat caused an estimated 2.28 lakh deaths in India as per the Global Burden of Disease study, compared to just 215 reported by the National Centre for Disease Control. This massive underreporting masks a growing [public health emergency](#).

More global analysis with focus on elder people

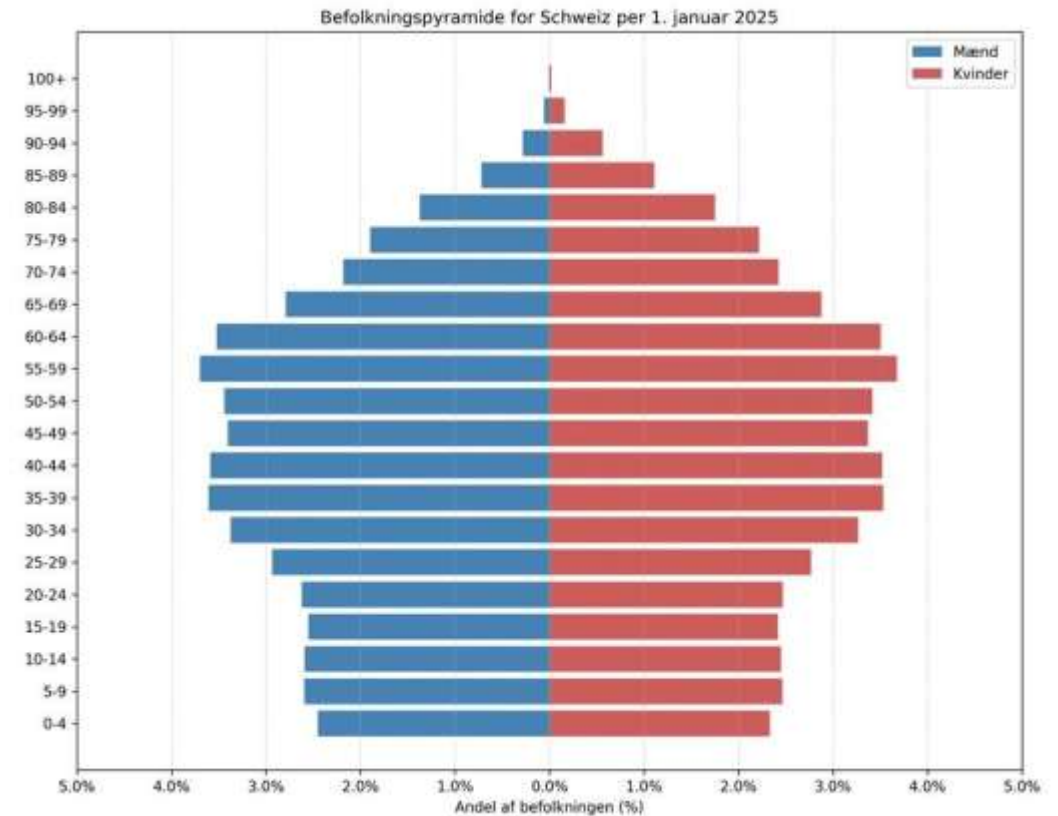
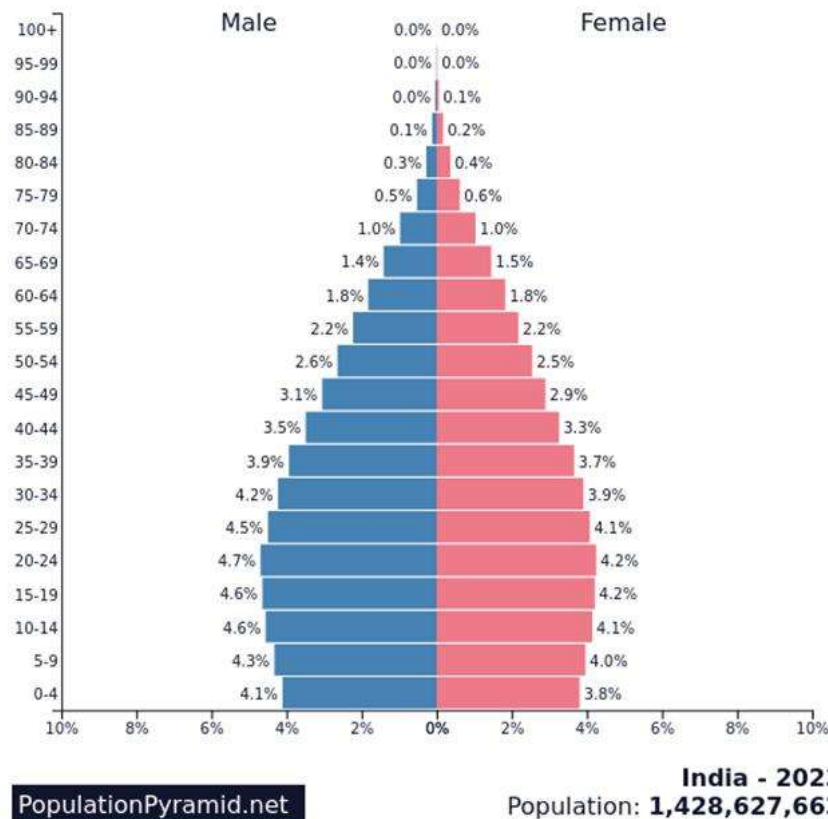
Exceeding human heat tolerance in a warming, ageing world: a global projection modelling study

Qinqin Kong, Daniel J Vecellio, Matthew Huber, Rachel M Cottle, S Tony Wolf, Olivia K Leach, Kat G Fisher, Eran Bendavid, W Larry Kenney

- Older adults faced more frequent and spatially extensive exceedances under the 1.5°C global warming scenario relative to the preindustrial period than young adults did under 4°C.
- Using age-specific thresholds more than doubled the global population having 180 h or more of exceedance annually as compared with previous estimates.
- Our results suggest accounting for age stratified vulnerability, **intolerable heat will be experienced at much larger scales and for longer durations, affecting far more people than previously estimated**



Demographic comparison pyramid, different situation, more elder people at risk in Europe





Diagnosis of existent and newly built (passive design against new practice of aluminium shuttering)

- Many buildings including newly built are not well designed to protect the inhabitants who very often do not have air conditioning.
- The improvement of building envelope will take time.
- It is urgent to develop and make available for the low-income people a low energy affordable evaporative cooling system



- Surface temperature of different walls in Apartment 2_AAC showed minimal variation of 0.2–0.5°C. The highest surface temperature registered here was ~33°C.

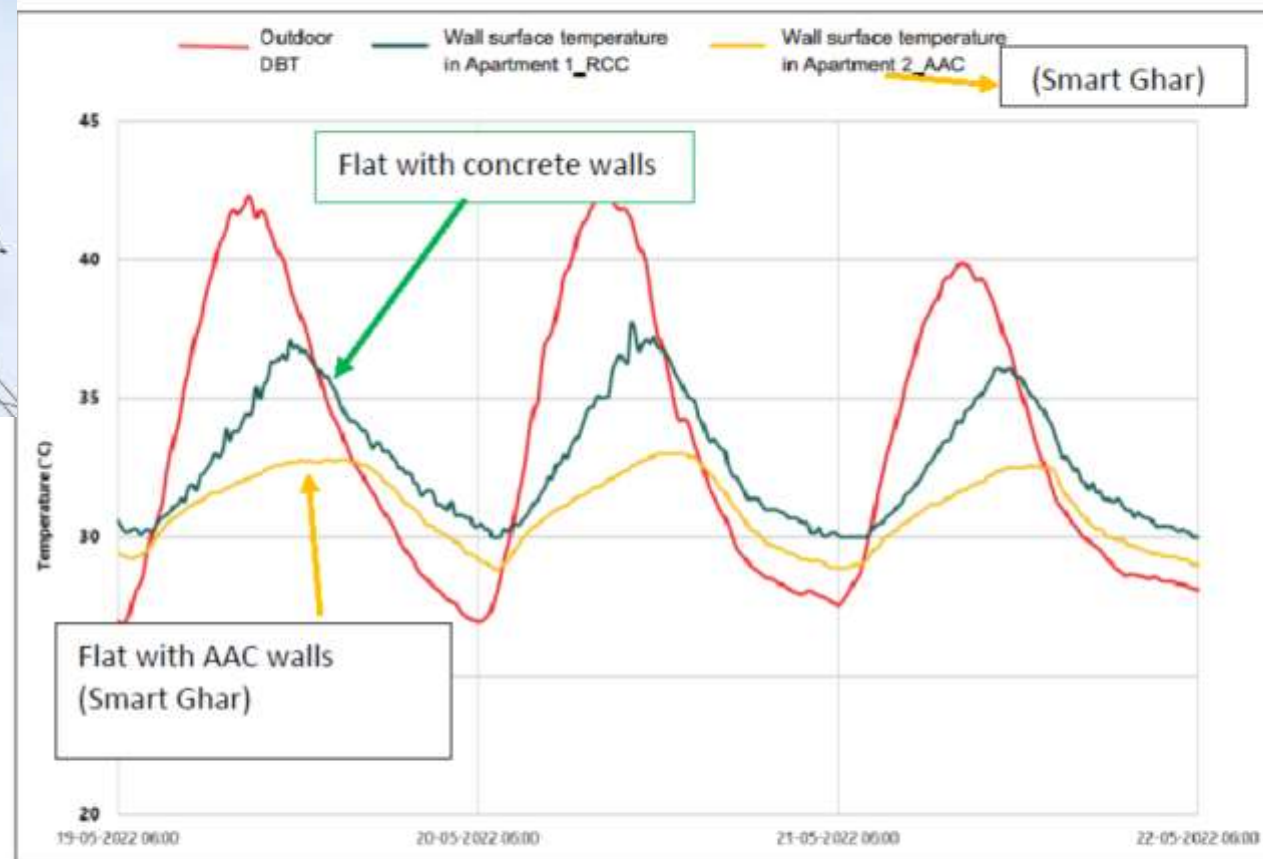


Figure 8 Internal wall surface temperature of one west-facing wall in Apartment 1_RCC and Apartment 2_AAC (19–21 May 2022)





Example of heat waves and climatic zones

- The area of very high temperature is very large in India
- When the temperature rise above 40°C the wet bulb does anymore increase

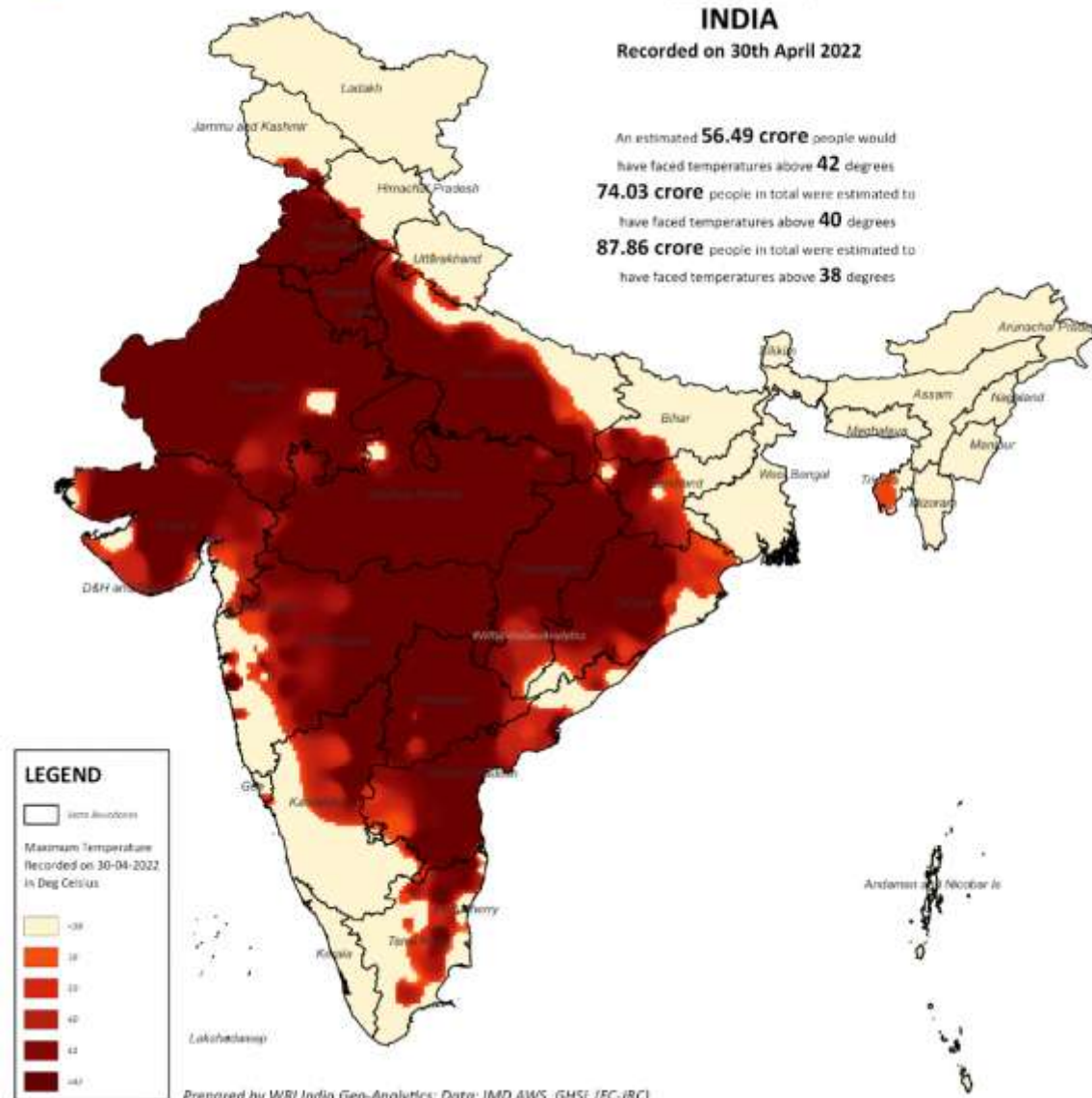


EXPOSURE TO HIGH TEMPERATURES

INDIA

Recorded on 30th April 2022

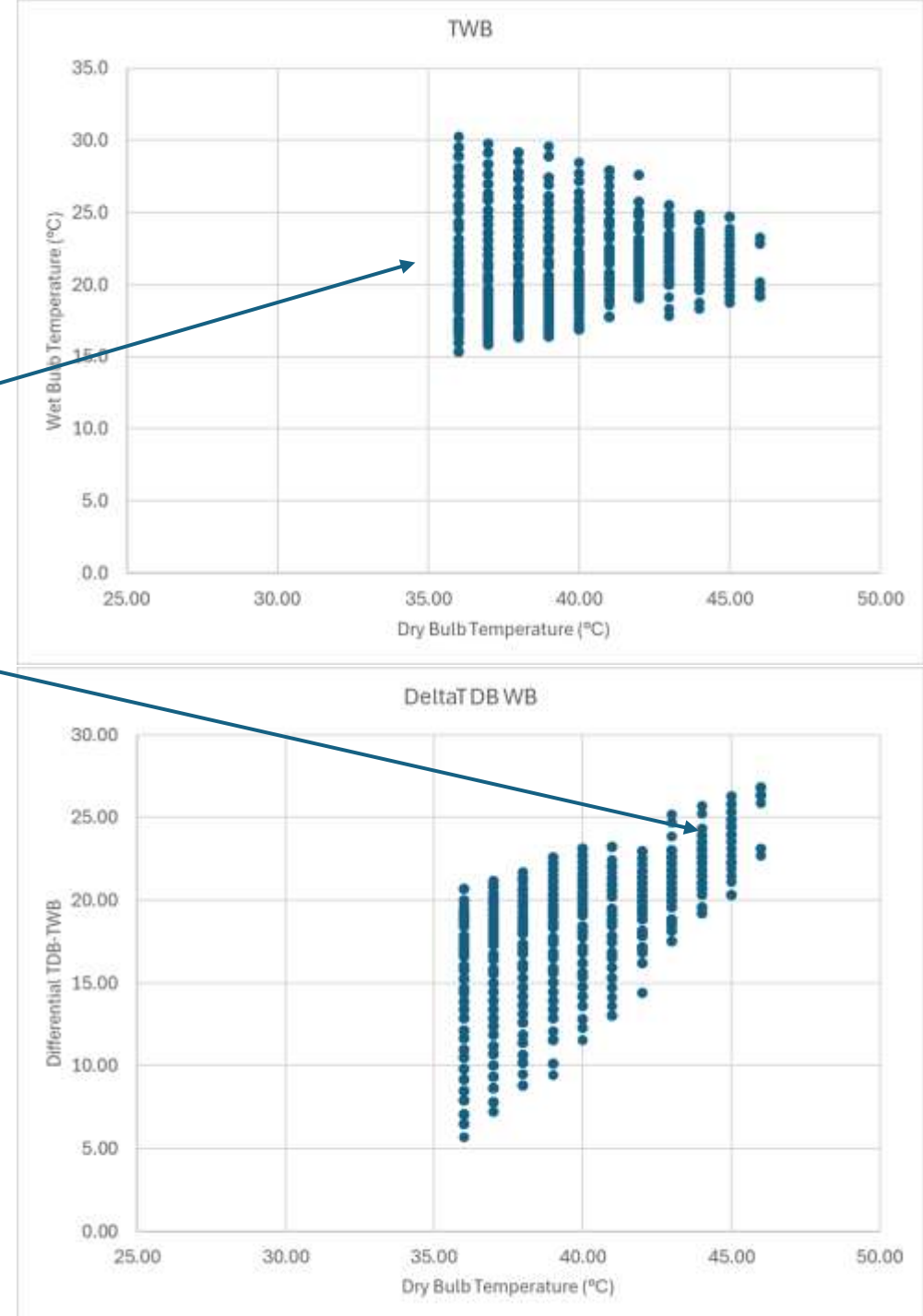
An estimated **56.49 crore** people would have faced temperatures above **42** degrees
74.03 crore people in total were estimated to have faced temperatures above **40** degrees
87.86 crore people in total were estimated to have faced temperatures above **38** degrees





Heat waves

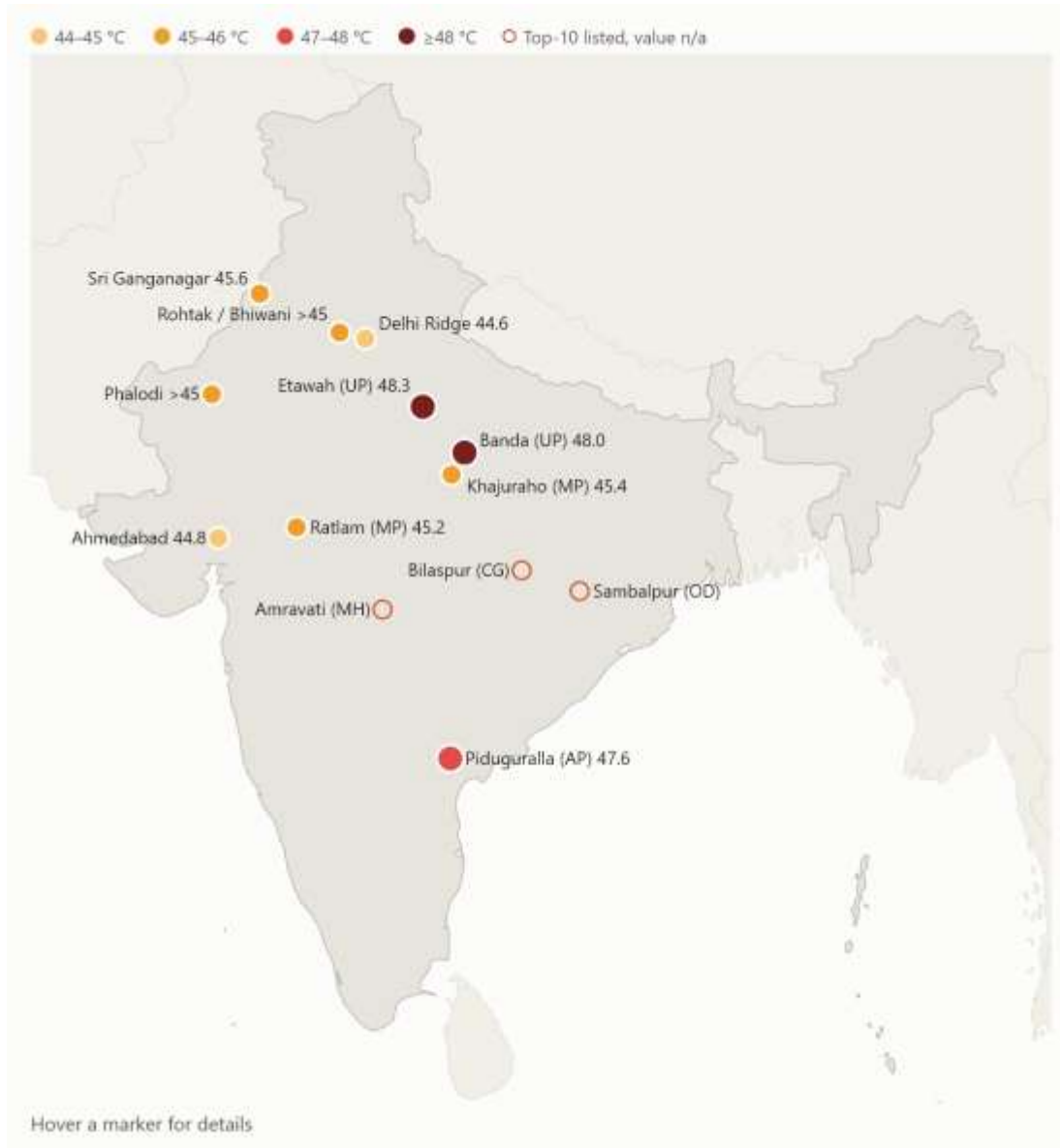
- In dry hot climates, the wet bulb temperature decreases (trend) when DB increases above 40 °C,
- The differential TDB-TWB (depression) increases significantly (Delhi ...)
- So the evaporative cooling potential increases for higher temperatures (> 40°C)
- So, with 65% evaporation efficiency, the air temperature after the evaporative pad is about 10-15°C lower





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India 44-48.3 °C Europe is “progressing” fast ... 48.8 °C peak in Sardinia





Importance of ceiling fans

- New high performance ceiling fans

Atomberg vs. Standard AC & EESL Fans

Feature / Metric	Atomberg BLDC Fans	Standard AC Fans
Power Consumption	3.8W (Speed 1) to 28W-35W (Speed 5)	70W – 90W
Air Delivery (CMM)	~220 – 250 CMM 15000 m3/h	Varies (often noisy or lower efficiency)
Motor Type	Brushless DC (BLDC) with atomSENSE algorithm	AC Induction (with capacitor & wire coils)
Lifespan	15 – 20 years (zero friction)	5 – 10 years
Inverter Backup	Runs 2.5x to 3x longer on home inverter	Drains batteries quickly
Control & Smart Features	IR Remote, 6 speed settings, sleep mode, timer, Alexa/Google Home (on Smart variants)	Manual wall regulator (causes heat loss)

- Increase in the thermal comfort zone → IMAC-R +





India Model for Adaptive Comfort Residential (IMAC-R) Adaptive thermal comfort model based on field studies in five climate zones across India

Rajan Rawal ^{a,*}, Yash Shukla ^a, Vishnu Vardhan ^a, Sneha Asrani ^a, Marcel Schweiker ^b, Richard de Dear ^c, Vishal Garg ^d, Jyotirmay Mathur ^e, Sanjay Prakash ^f, Saurabh Diddi ^g, S. Vikash Ranjan ^h, Abdullah N. Siddiqui ⁱ, Govinda Somani ^h

^a Centre for Advanced Research in Building Science and Energy (CARBSE), CEPT University, Ahmedabad, India

^b Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany

^c School of Architecture, Design, and Planning, The University of Sydney, Sydney, Australia

^d Centre for IT in Building Science, International Institute of Information Technology, Hyderabad, India

^e Department of Mechanical Engineering, Malaviya National Institute of Technology, Jaipur, India

^f SHiFt - Studio for Habitat Futures, New Delhi, India

^g Bureau of Energy Efficiency, Ministry of Power, Government of India, New Delhi, India

^h Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, New Delhi, India ⁱ Faculty of Architecture and Ekistics, Jamia Millia Islamia, New Delhi, India

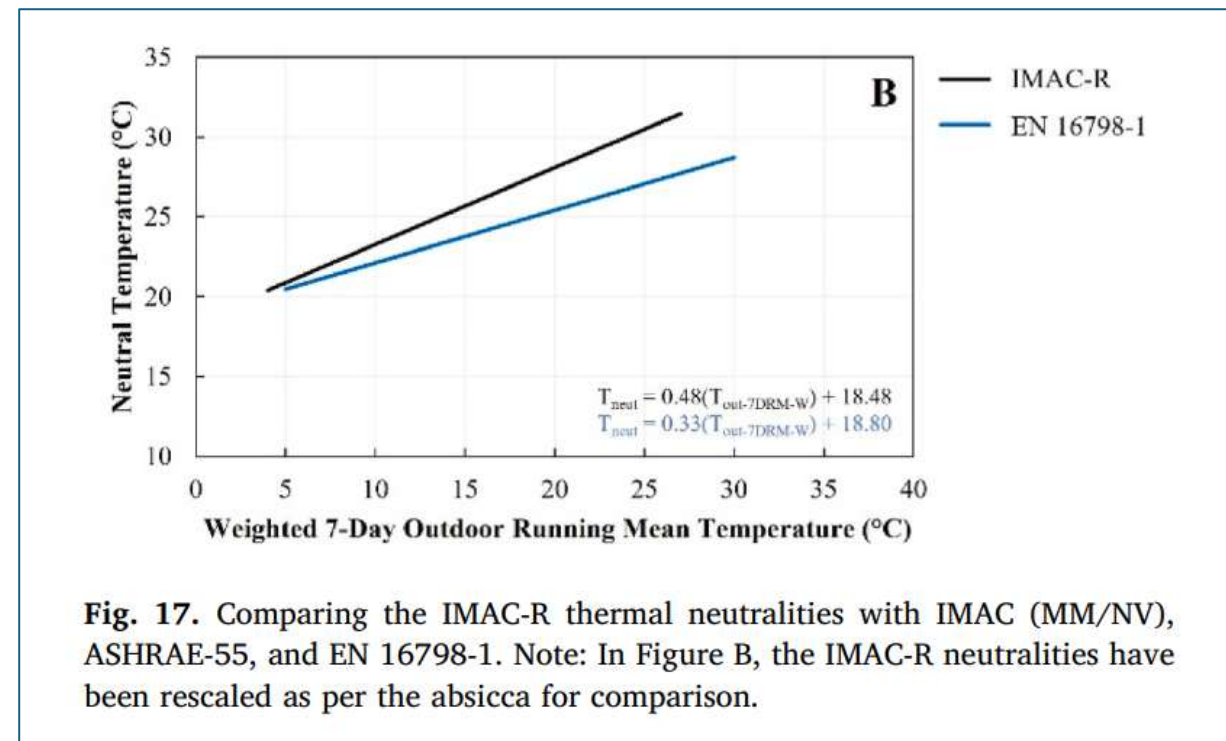
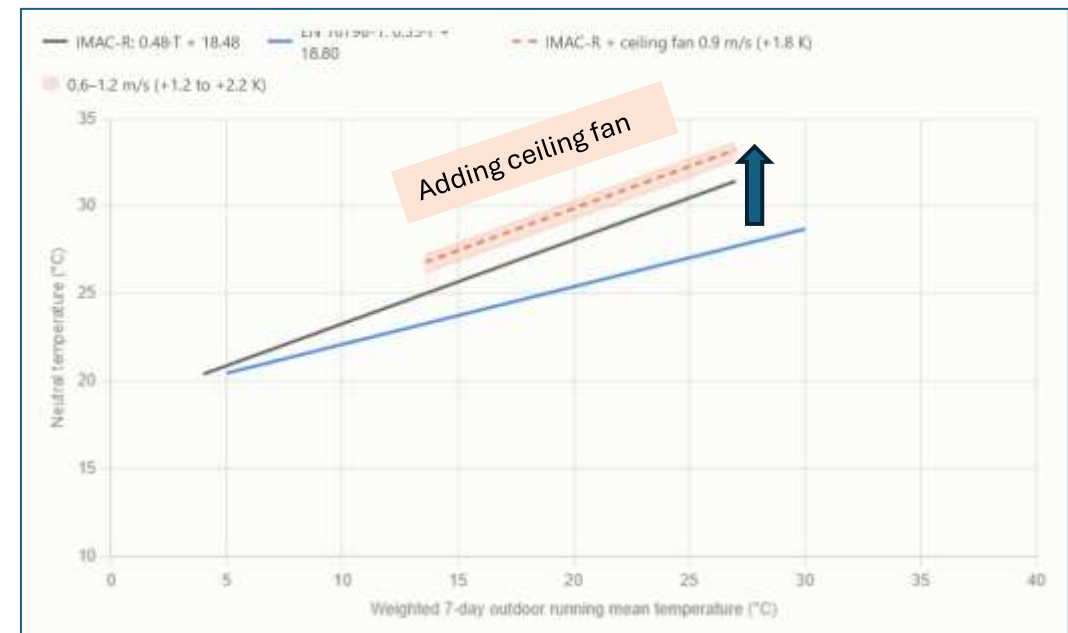


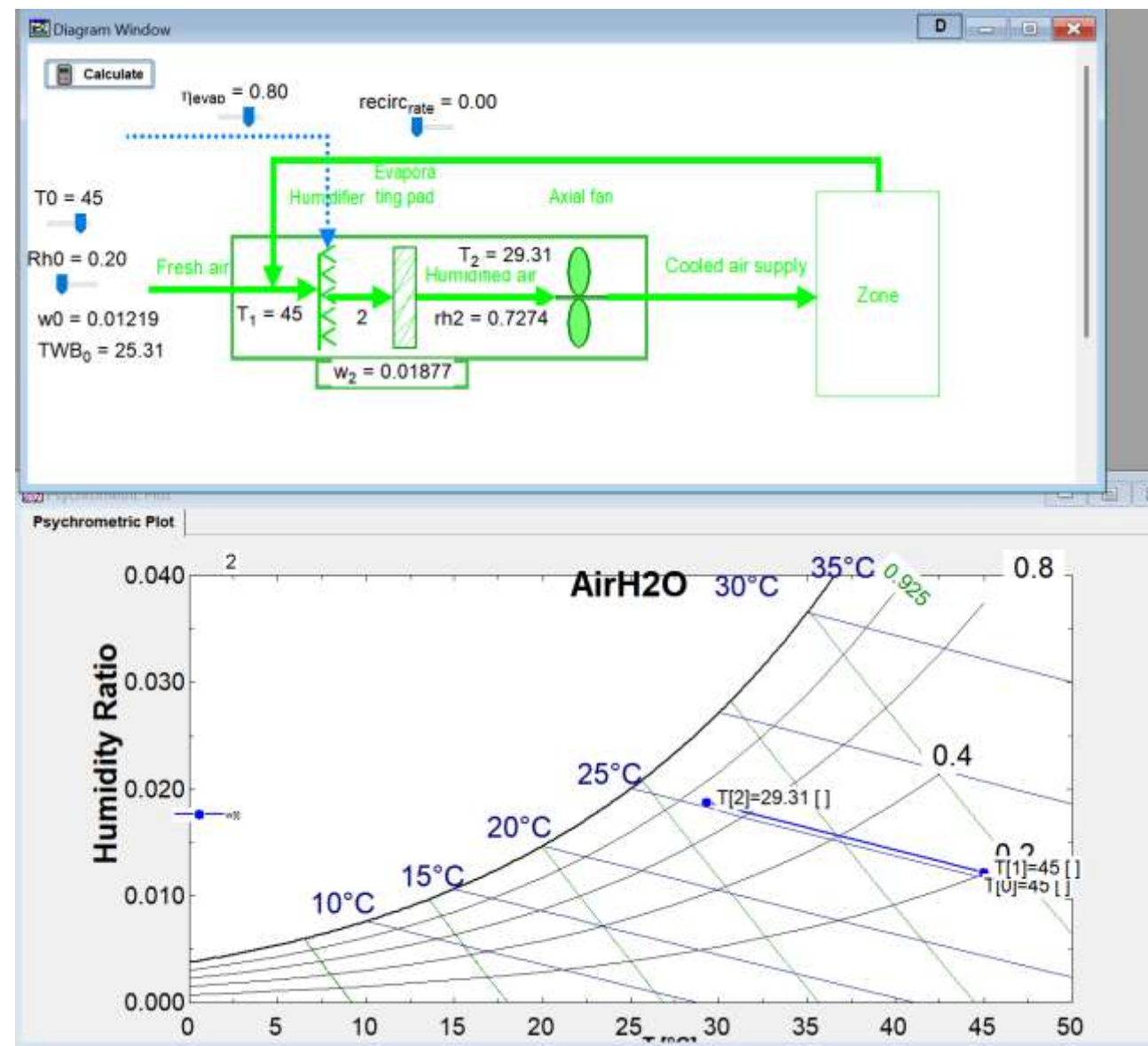
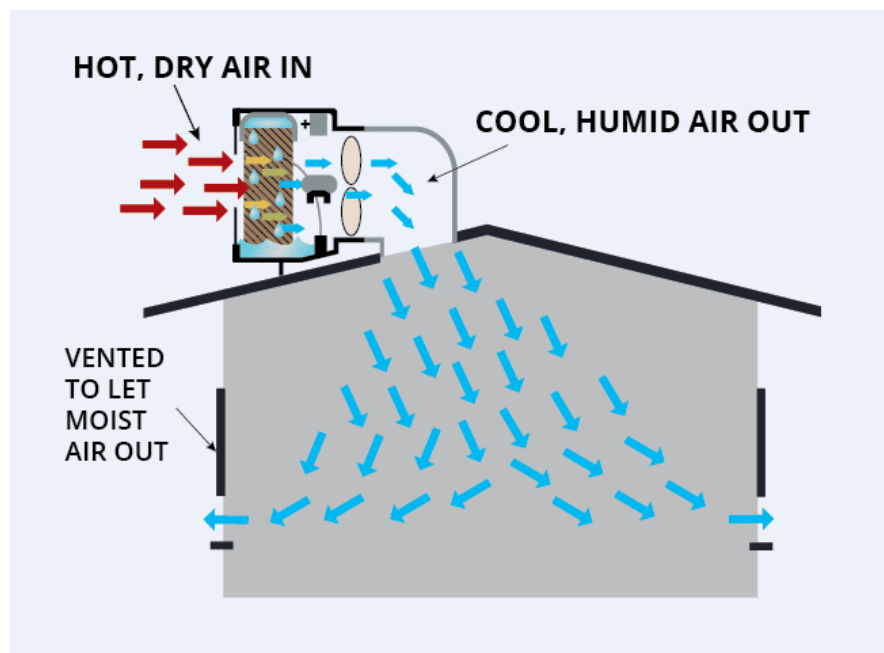
Fig. 17. Comparing the IMAC-R thermal neutralities with IMAC (MM/NV), ASHRAE-55, and EN 16798-1. Note: In Figure B, the IMAC-R neutralities have been rescaled as per the abscissa for comparison.





Centralised building retrofit evaporative system

- Use of central stair well
- Blow from the roof with a big axial fan and evaporative cooling pad or high-pressure mist





Typical on roofs (example)2 stage)

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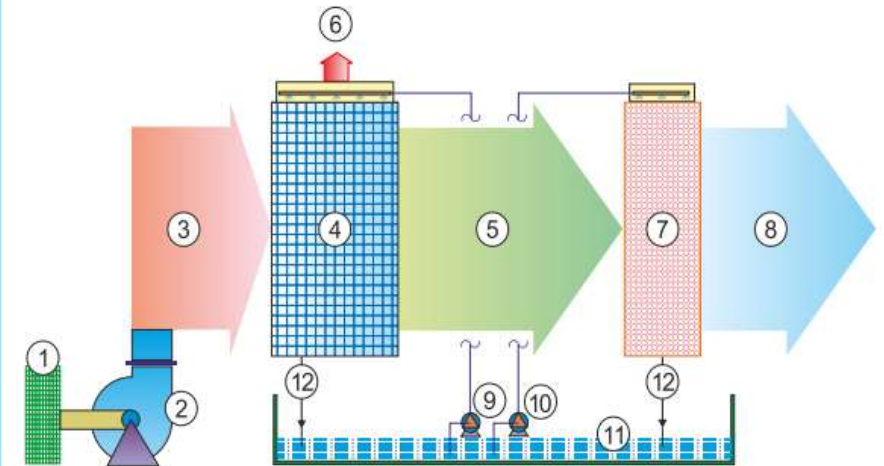
- HMX Ambiator



Outlet temperature chart for HMX-Ambiator

Ambient DBT (°C)	Relative Humidity					
	10%	15%	20%	25%	30%	35%
28	7.2	9.0	11.0	12.5	14.0	15.5
30	8.2	10.1	11.9	13.9	15.4	17.0
32	9.3	11.3	13.2	15.2	16.8	18.3
34	10.3	12.4	14.5	16.3	18.3	19.9
36	11.3	13.6	15.6	17.7	19.8	21.4
38	12.3	14.7	17.0	19.1	21.0	22.0
40	13.3	15.9	18.3	20.5	22.5	24.5
42	14.8	17.1	19.6	21.9	24.0	25.9
44	15.4	18.4	21.0	23.3	25.5	27.5
46	16.4	19.5	22.3	24.8	27.0	29.1
48	17.4	20.8	23.7	26.2	28.6	30.4
50	18.5	22.0	25.1	27.7	30.1	32.3

Principle of operation



- 1 Air pre-filter
- 2 Air blower
- 3 Filtered ambient air
- 4 HE1 - sensible heat exchanger for cooling air without adding water
- 5 Primary supply air is cooled without addition of water
- 6 Secondary exhaust air used to cool primary supply air in sensible heat exchanger
- 7 HE2 - adiabatic heat exchanger for cooling air
- 8 Conditioned air at machine outlet
- 9 Water supply pump for HE1
- 10 Water supply pump for HE2
- 11 Water sump
- 12 Return of water from HE1 and HE2 to sump

NA NA NA NA NA

(N/A - Not Applicable)

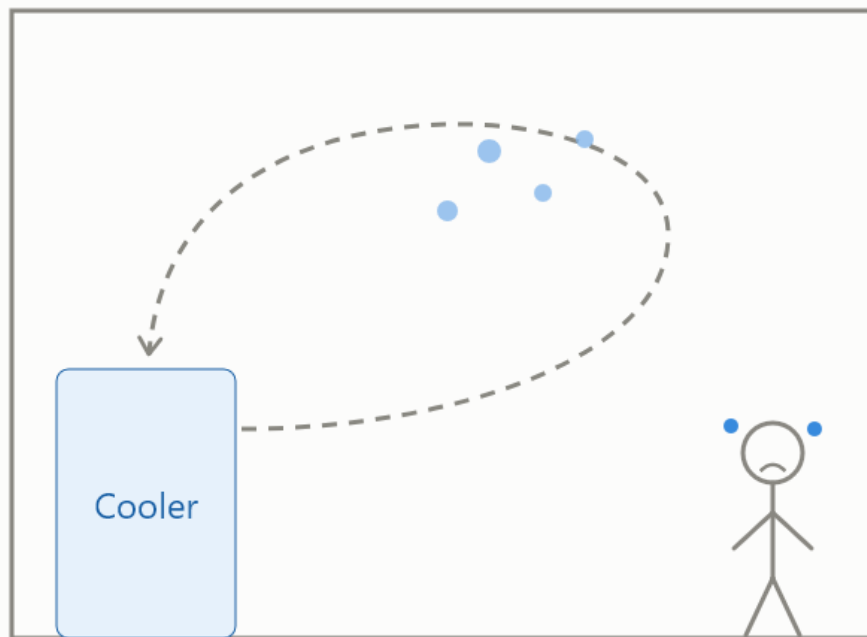


In Europe (except Spain) false judgement by lack of knowledge

- In some cases there have been testing of evaporative cooling without air change

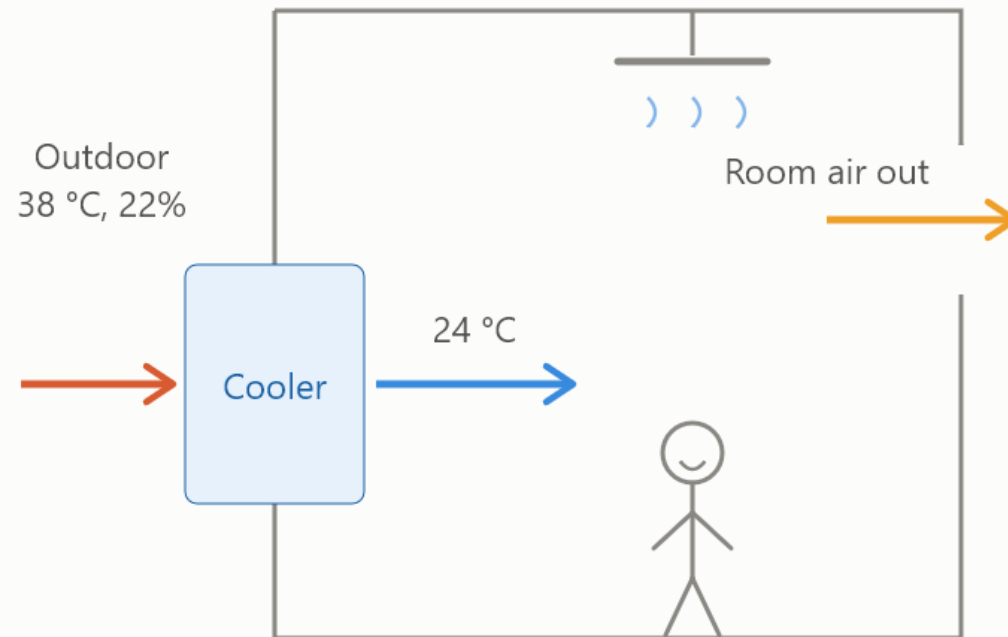


No air change (closed test room)



Within minutes: ~31 °C, RH towards 95%
Supply = room air, so $h_{\text{supply}} = h_{\text{room}}$
Net cooling $Q = 0$

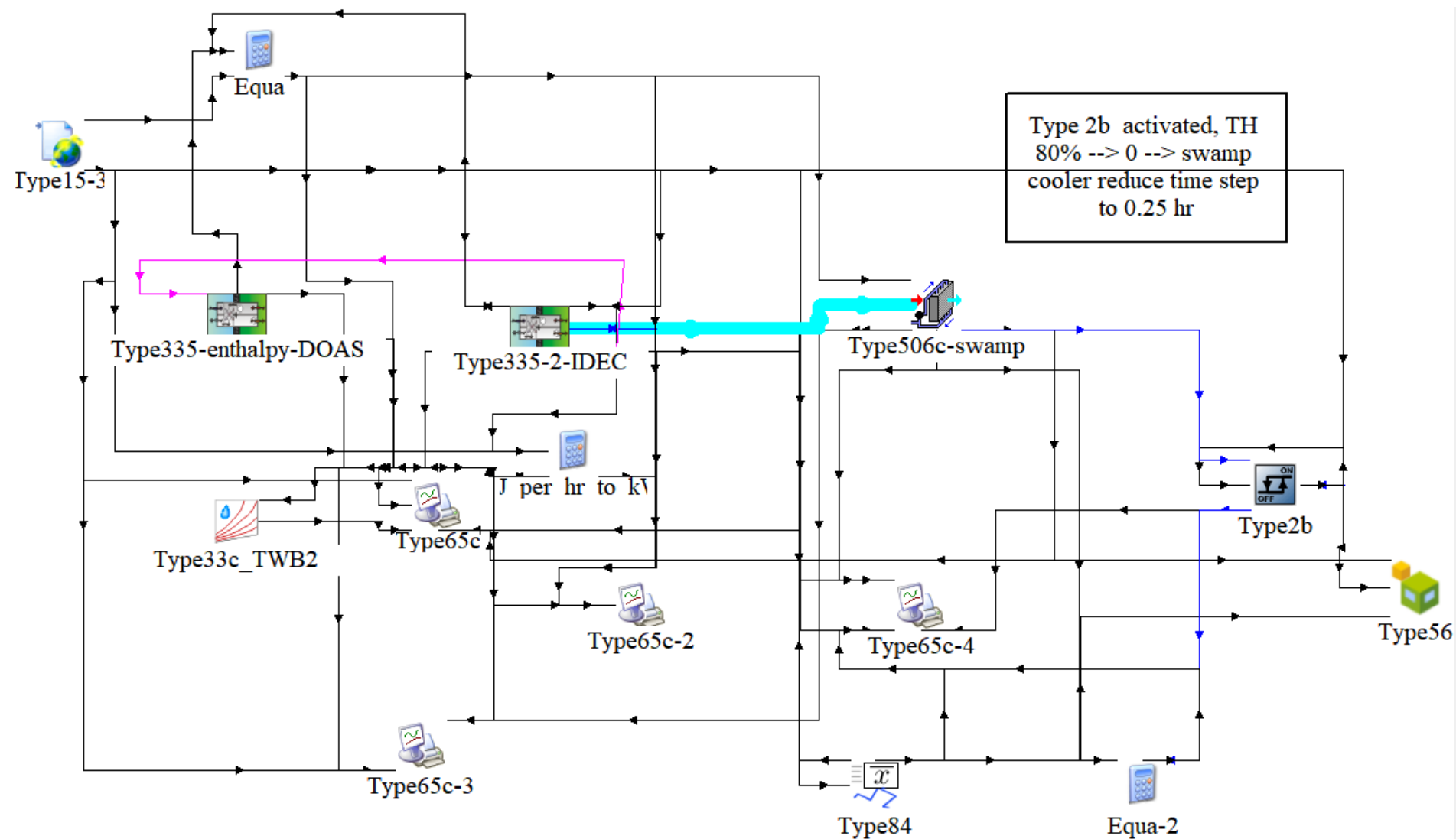
Once-through air (real use)



Room ~27 °C, ~67% RH with 3 K of gains
Heat leaves with the exhaust air
 $Q = \dot{m} (h_{\text{room}} - h_{\text{outdoor}}) > 0$

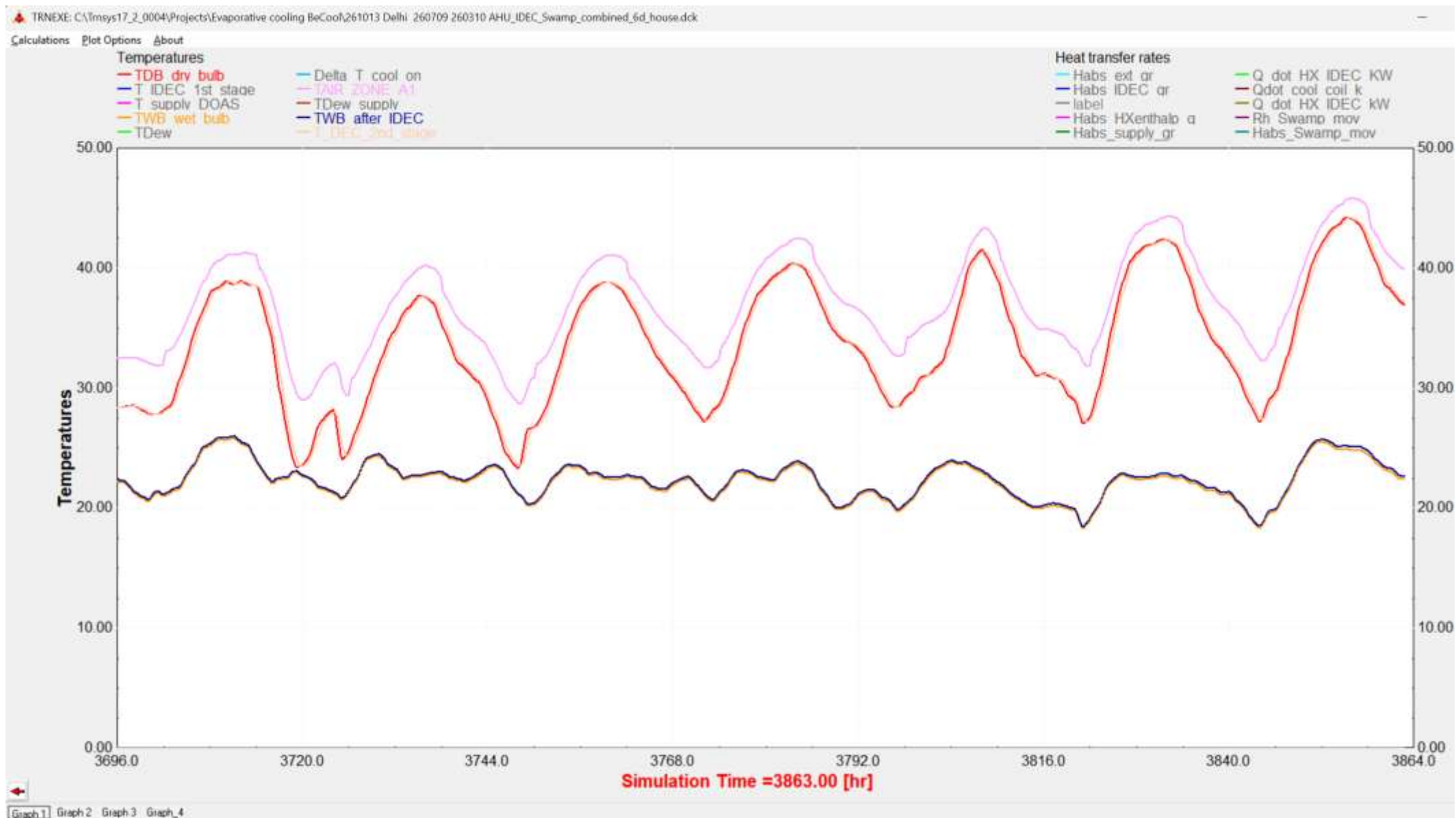


Dynamic simulation with TRNSYS IDEC and DEC





Example without evaporative cooling, only air supply (Delhi climate) (Simulation with TRNSYS 17)





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TRNEXE: C:\Trnsys17_2_0004\Projects\Evaporative cooling BeCool\261013 Delhi 260709 260310 AHU_IDEC_Swamp_combined_6d_house.dck

Calculations Plot Options About

Temperatures

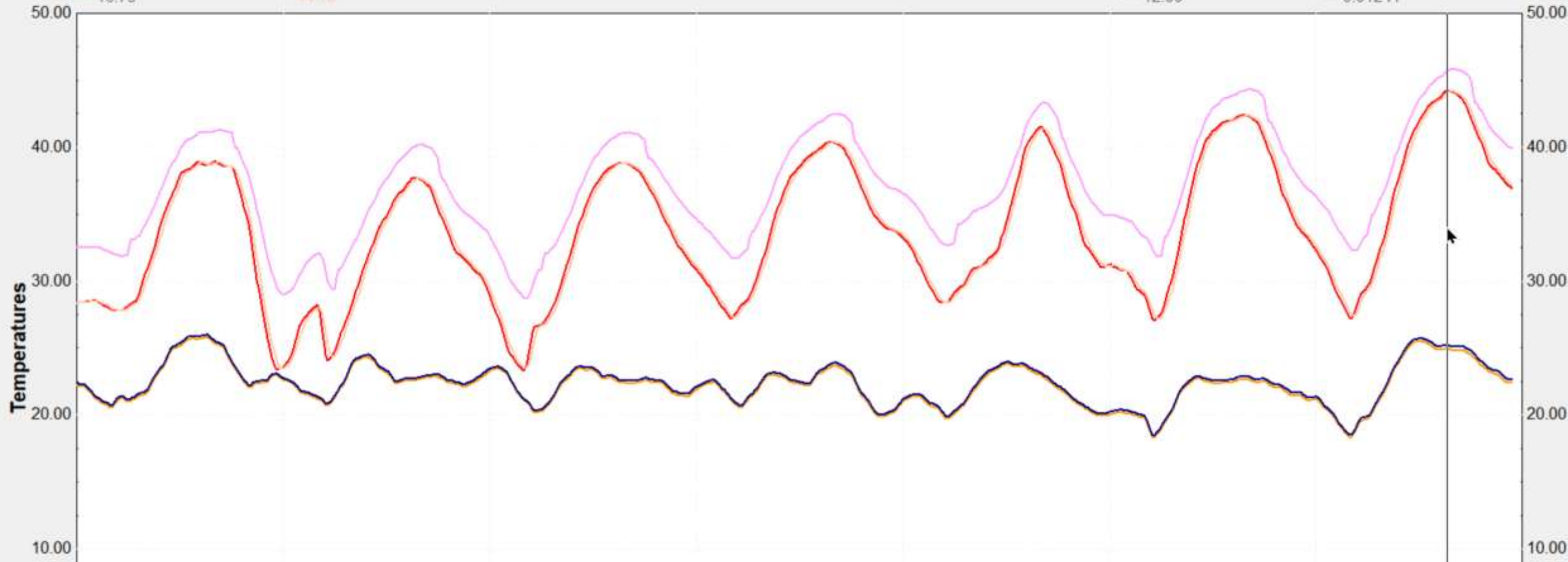
44.28
44.28
26.00
24.98
16.79

18.28
48.75
16.86
25.24
44.10

Heat transfer rates

12.40
12.40
0.00
12.40
12.00

0.00
14.46
0.00
21.65
0.01241





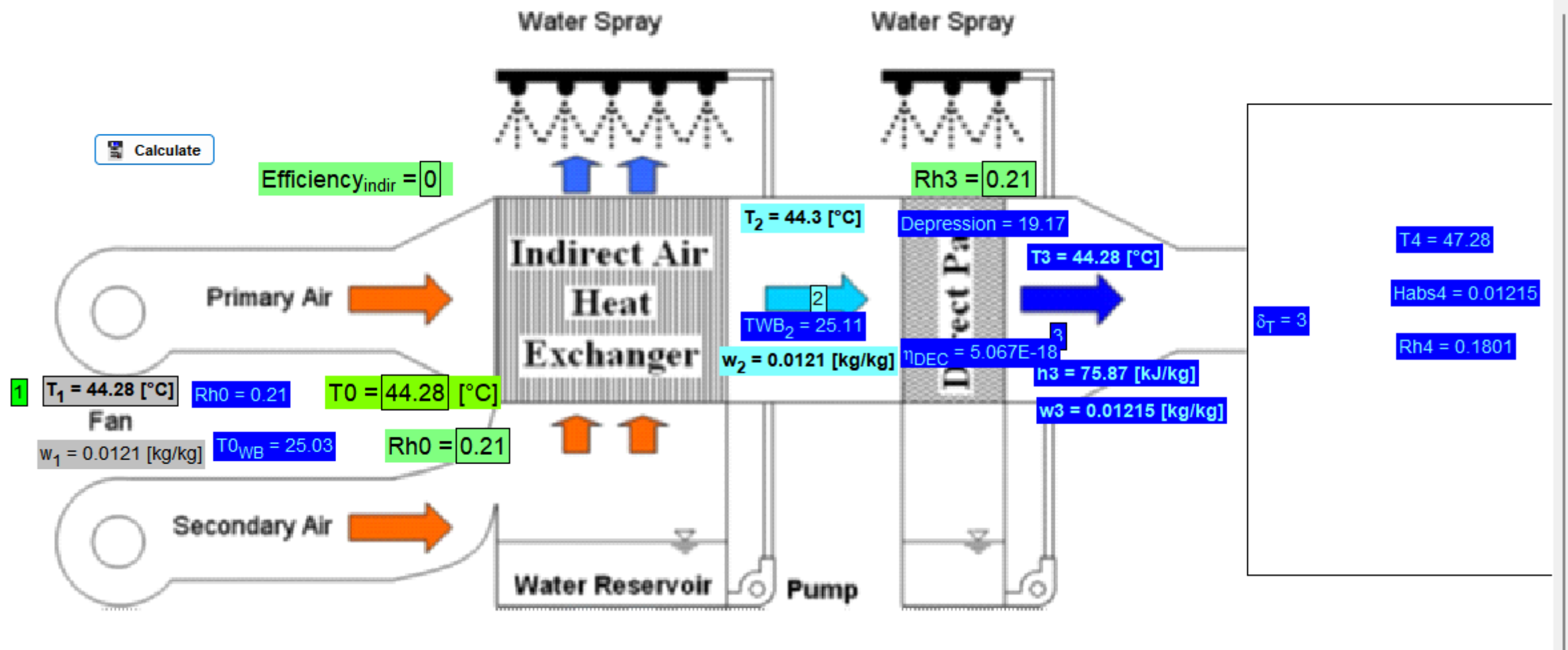
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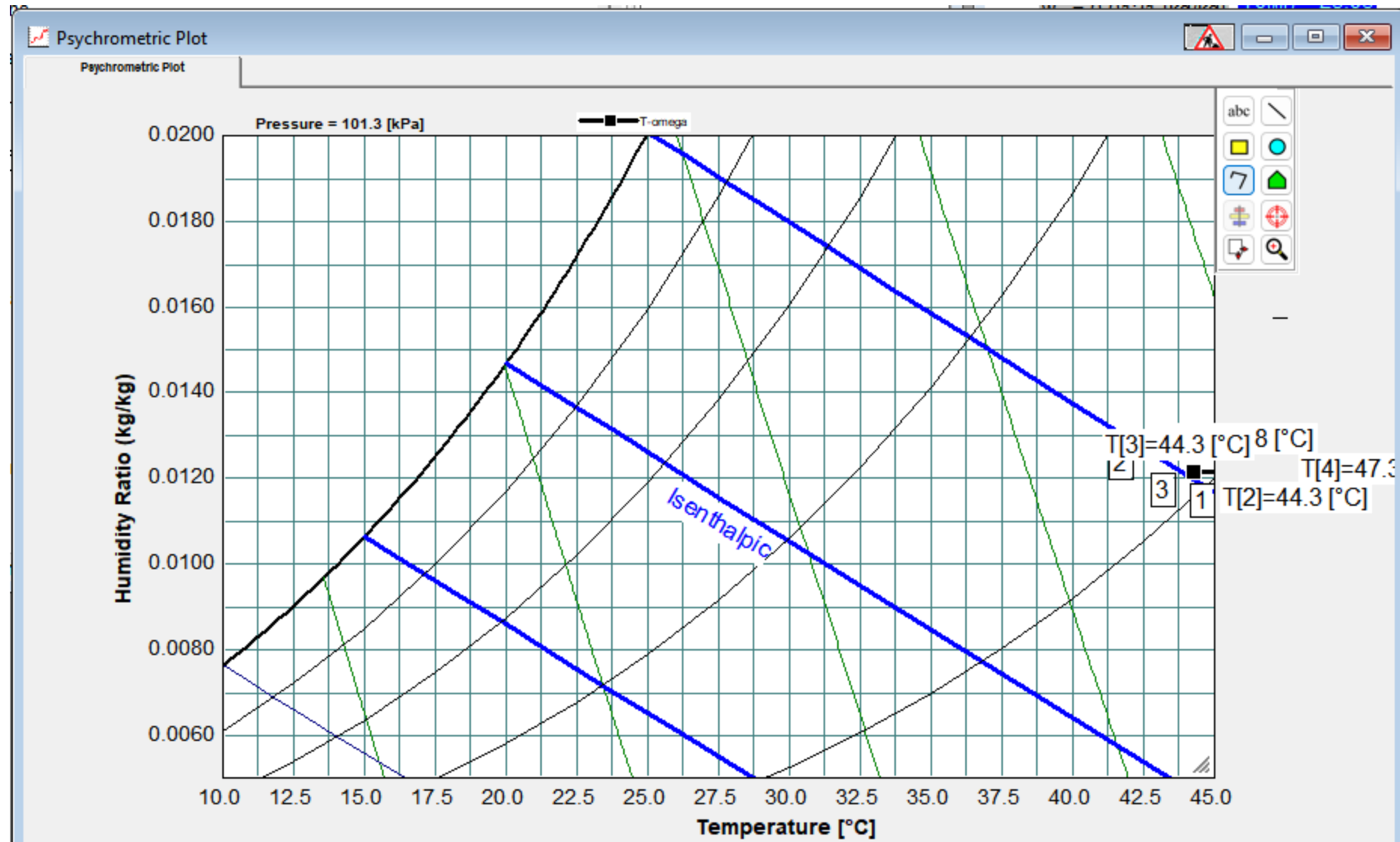
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Diagram Window





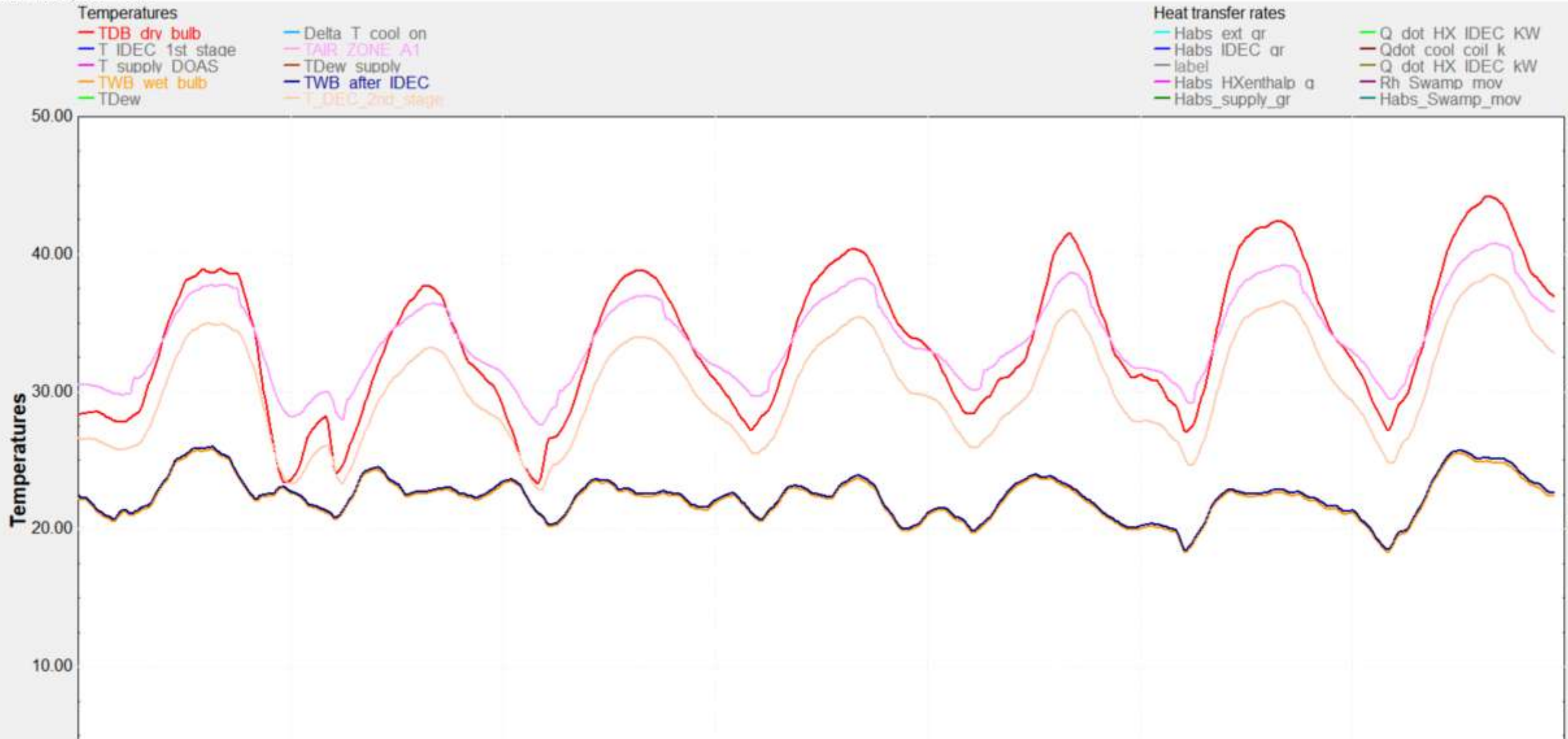


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Example with evaporative cooling, 30 % efficiency (Delhi climate)

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Calculations Plot Options About





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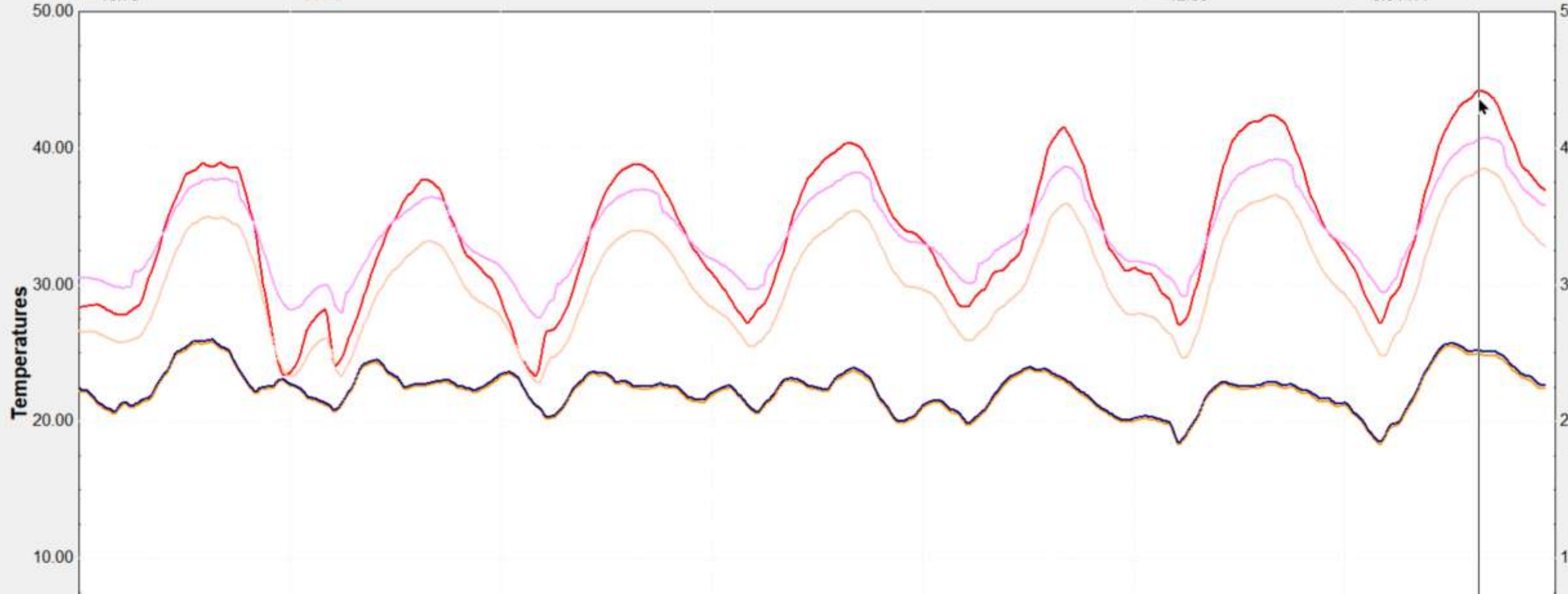
Calculations Plot Options About

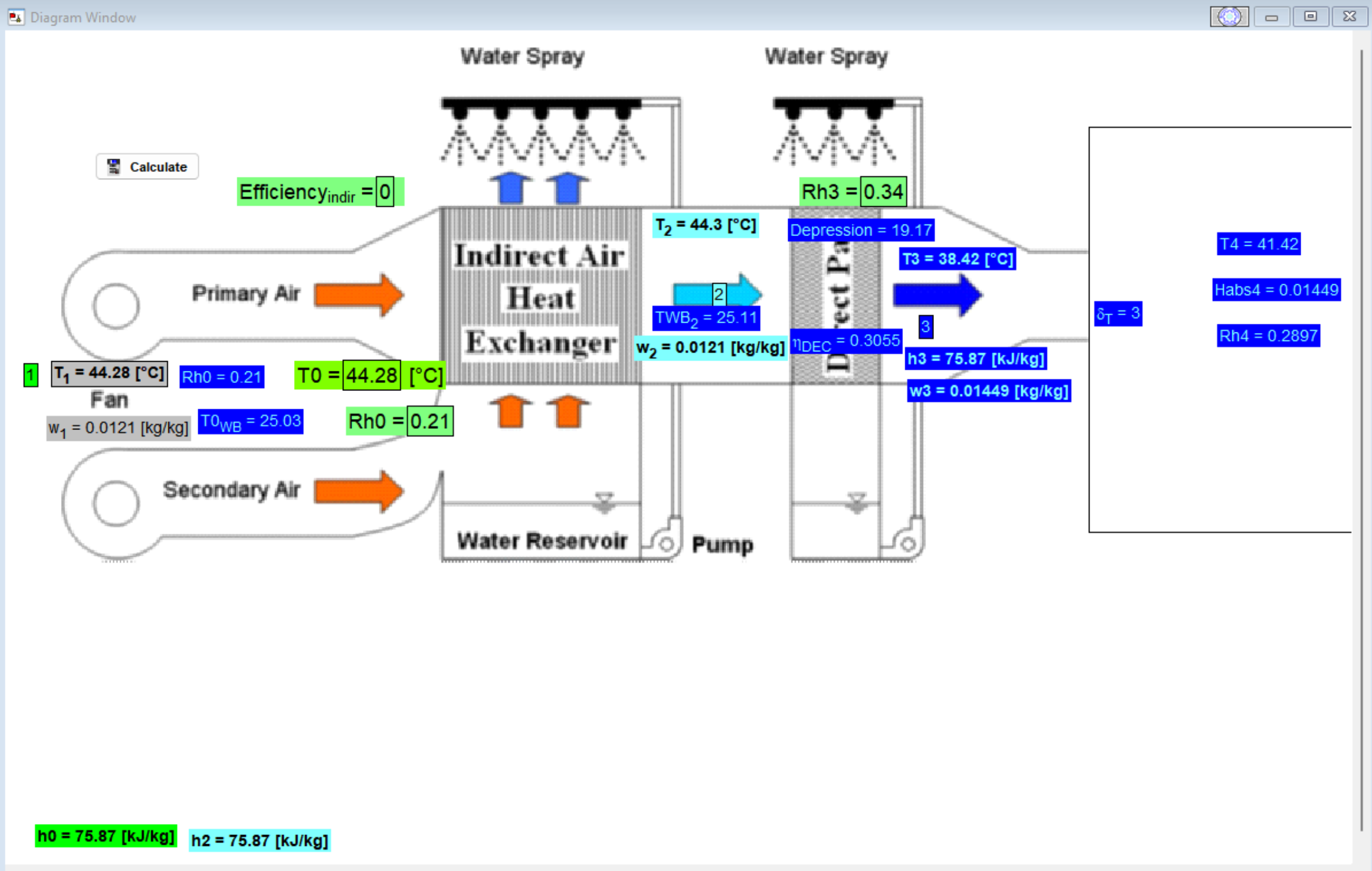
Temperatures

44.28	18.28
44.28	40.72
26.00	16.86
24.98	25.24
16.79	38.43

Heat transfer rates

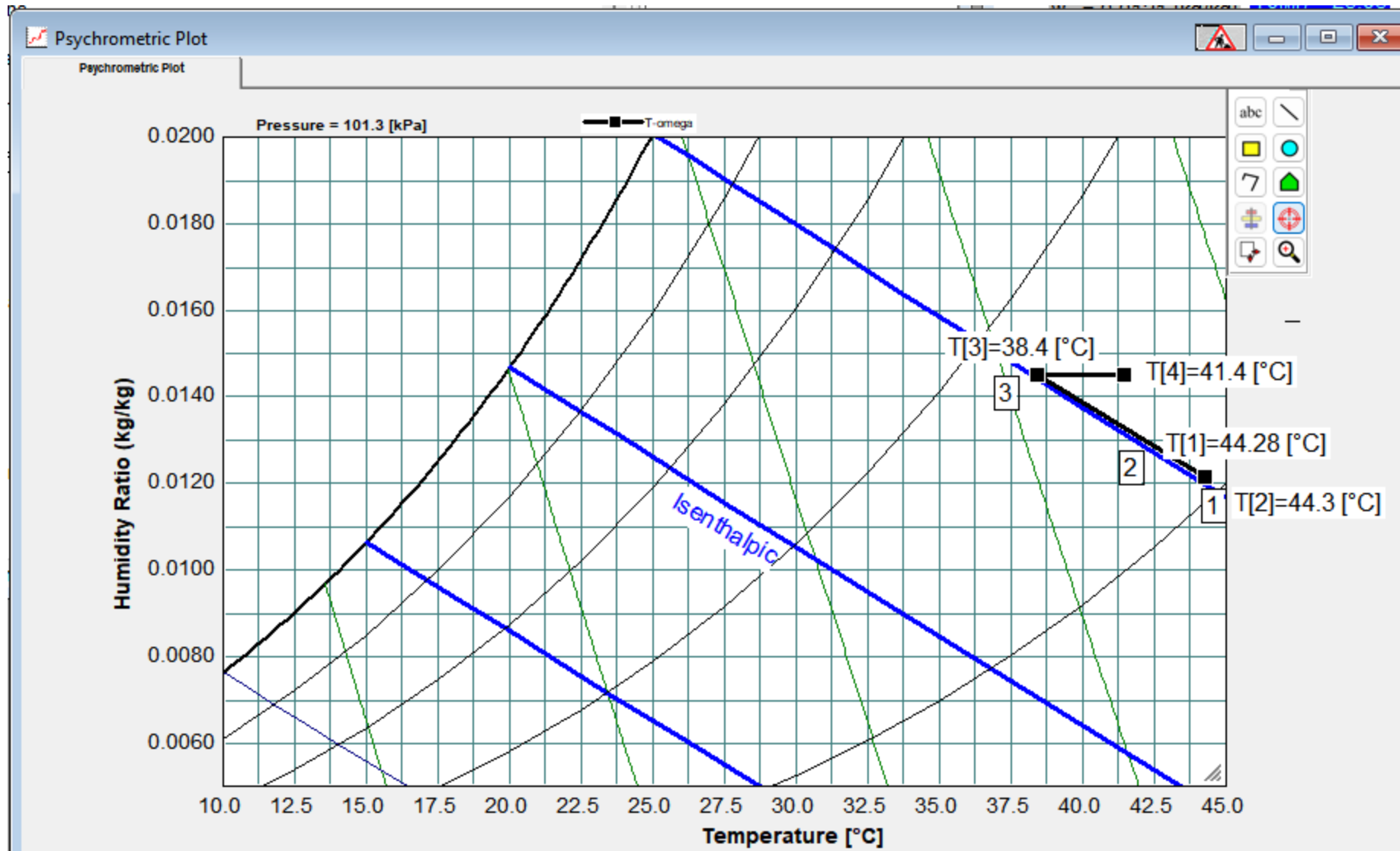
12.40	0.00
12.40	12.52
0.00	0.00
12.91	34.62
12.00	0.01477







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Example with evaporative cooling, 65 % efficiency (Delhi climate)

TRNEXE: C:\Trnsys17_2_0004\Projects\Evaporative cooling BeCool\261013 Delhi 260709 260310 AHU_IDEC_Swamp_combined_6d_house.dck

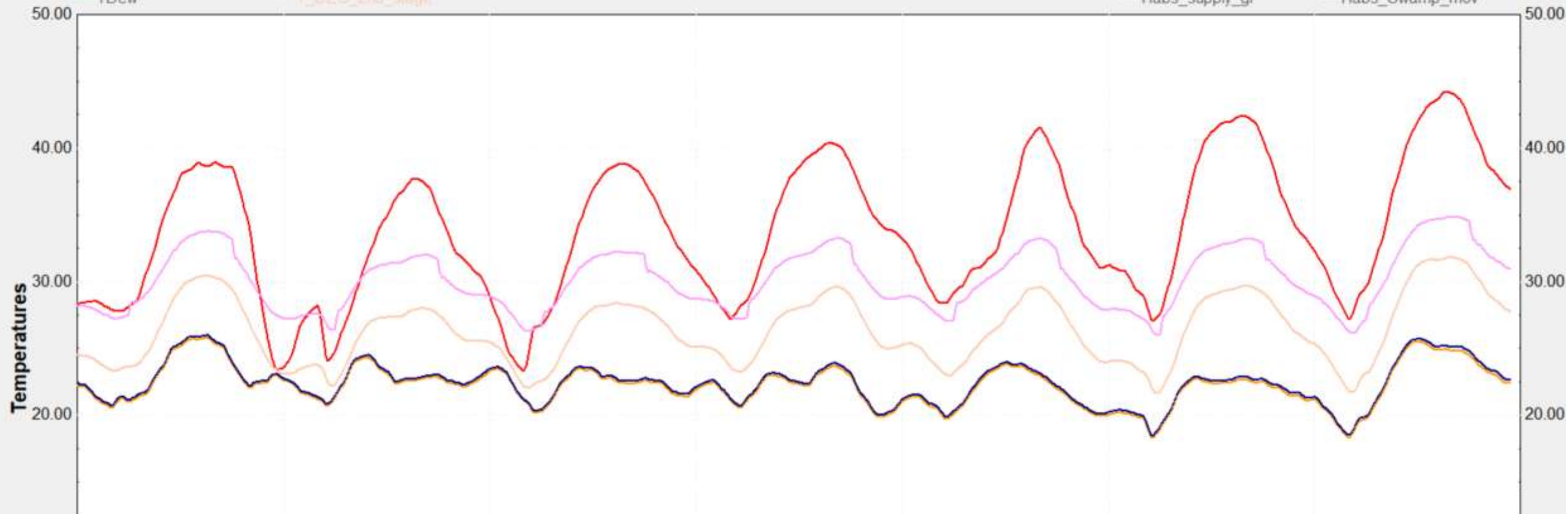
Calculations Plot Options About

Temperatures

- TDB dry bulb
- T IDEC 1st stage
- T supply DOAS
- TWB wet bulb
- TDew
- Delta T cool on
- TAIR ZONE A1
- TDew supply
- TWB after IDEC
- T_IDEC_2nd_stage

Heat transfer rates

- Habs ext gr
- Habs IDEC gr
- label
- Habs HXenthalp q
- Habs_supply_gr
- Q dot HX IDEC KW
- Qdot cool coil k
- Q dot HX IDEC KW
- Rh Swamp mov
- Habs_Swamp_mov

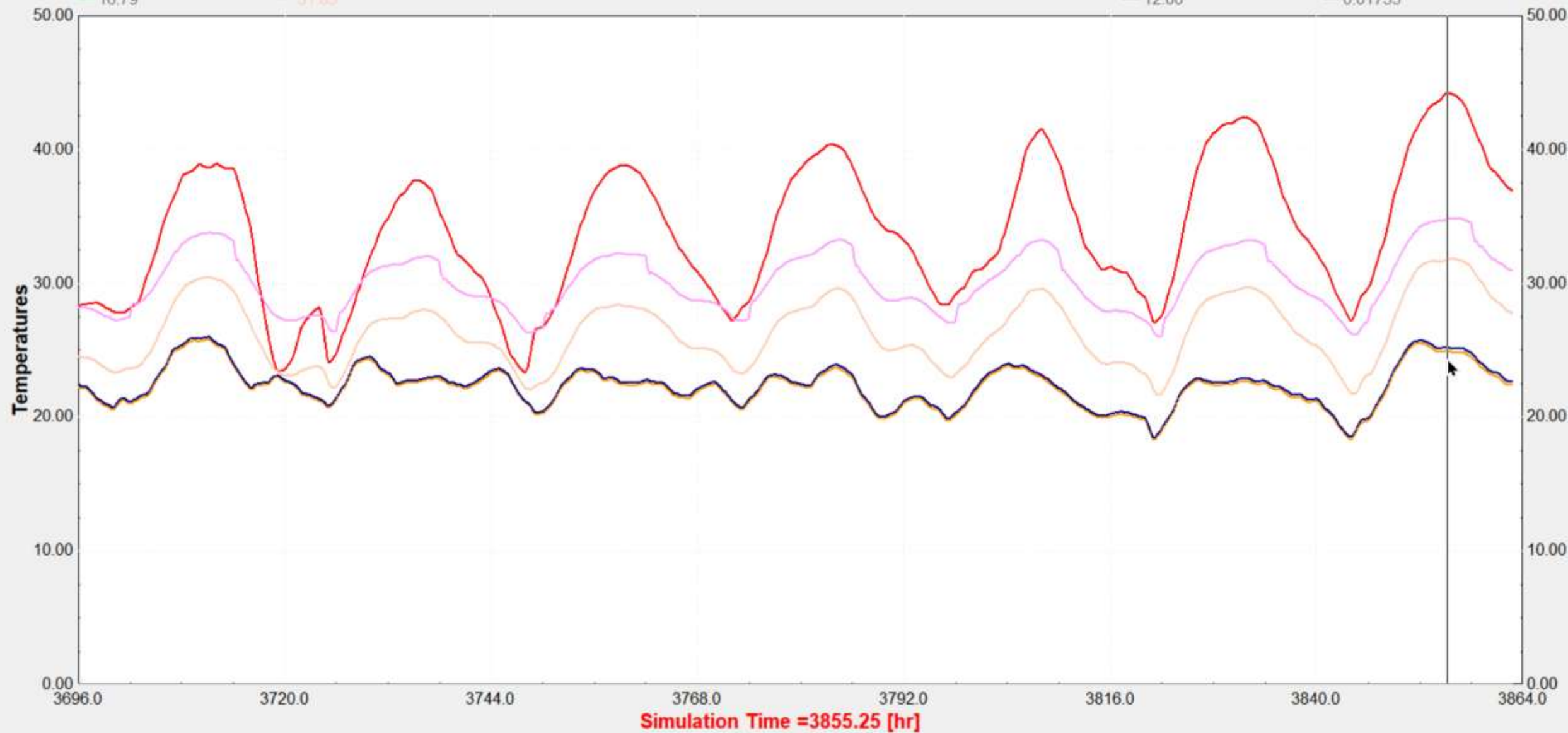


Temperatures

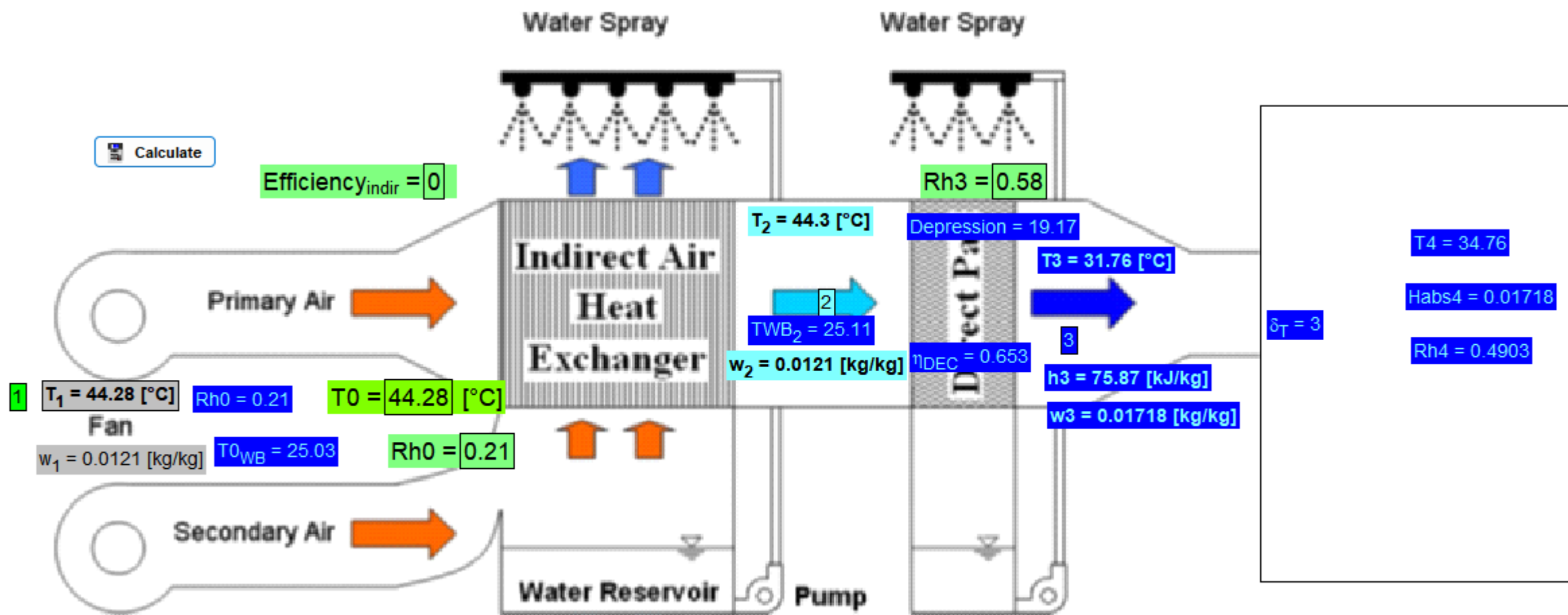
- 44.28
- 44.28
- 26.00
- 24.98
- 16.79
- 18.28
- 34.86
- 16.86
- 25.24
- 31.83

Heat transfer rates

- 12.40
- 12.40
- 0.00
- 12.91
- 12.00
- 0.00
- 9.610
- 0.00
- 59.01
- 0.01755

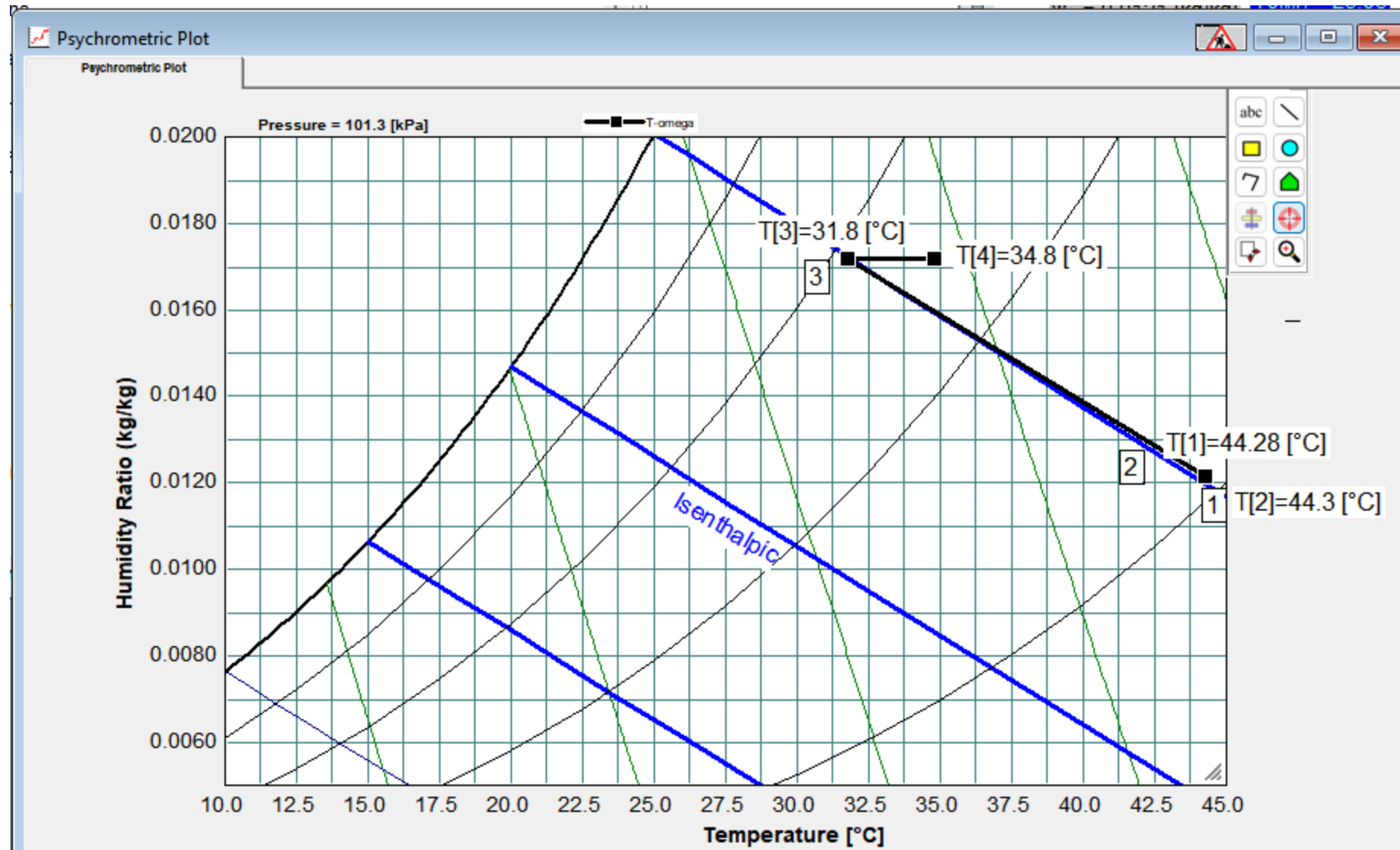


Simulation Time = 3855.25 [hr]





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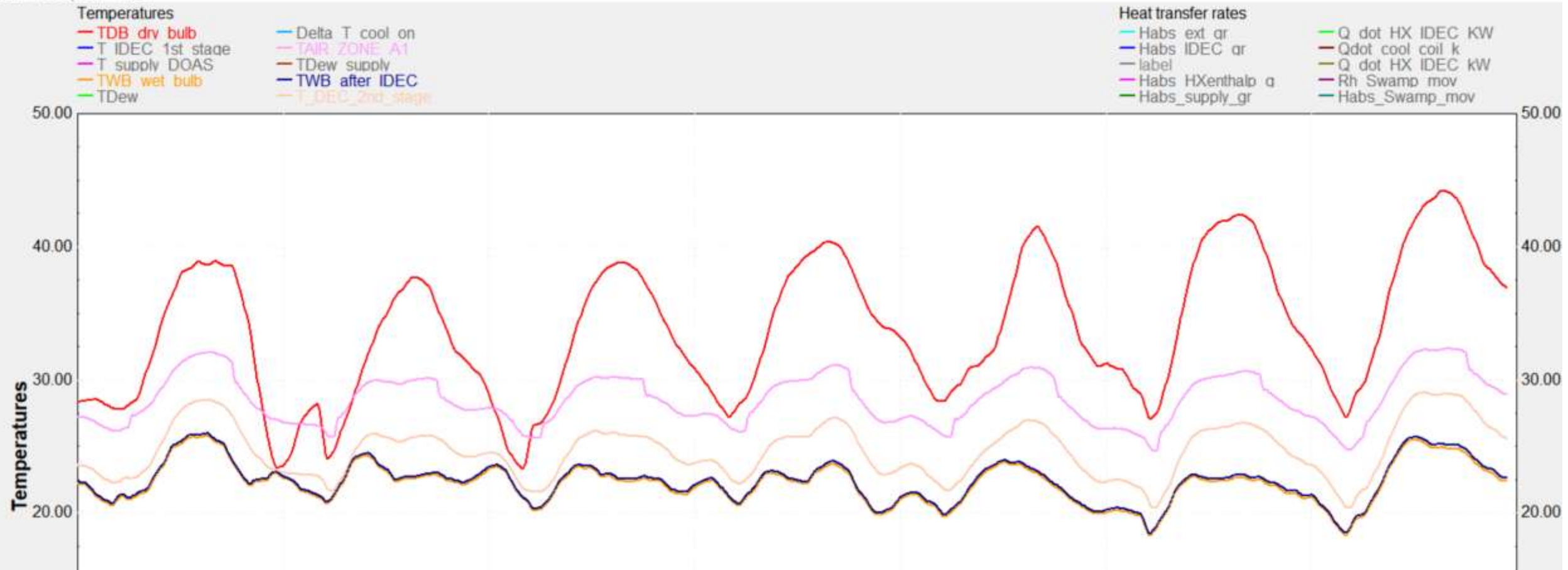




Example with evaporative cooling, 80 % efficiency (Delhi climate)

TRNEXE: C:\Trnxs17_2_0004\Projects\Evaporative cooling BeCool\261013 Delhi_260709_260310 AHU_IDEC_Swamp_combined_6d_house.dck

Simulations Plot Options About





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TRNEXE: C:\Trnsys17_2_0004\Projects\Evaporative cooling BeCool\261013 Delhi_260709_260310 AHU_IDEC_Swamp_combined_6d_house.dck

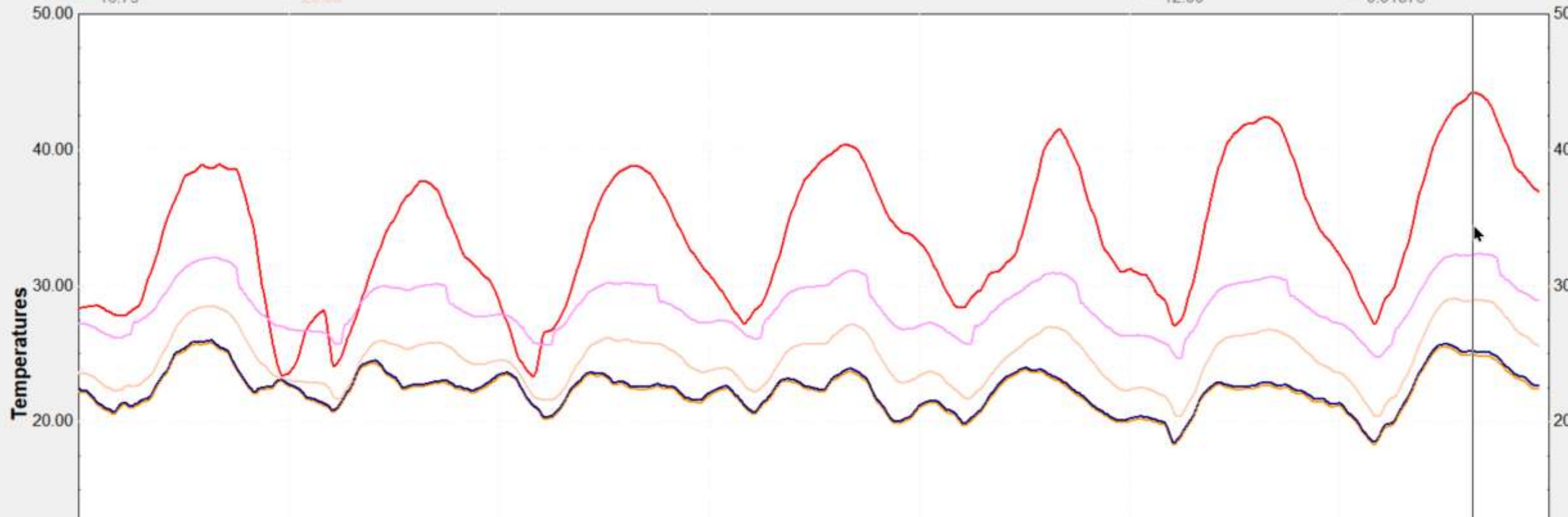
Calculations Plot Options About

Temperatures

44.28	18.28
44.28	32.35
26.00	16.86
24.98	25.24
16.79	29.00

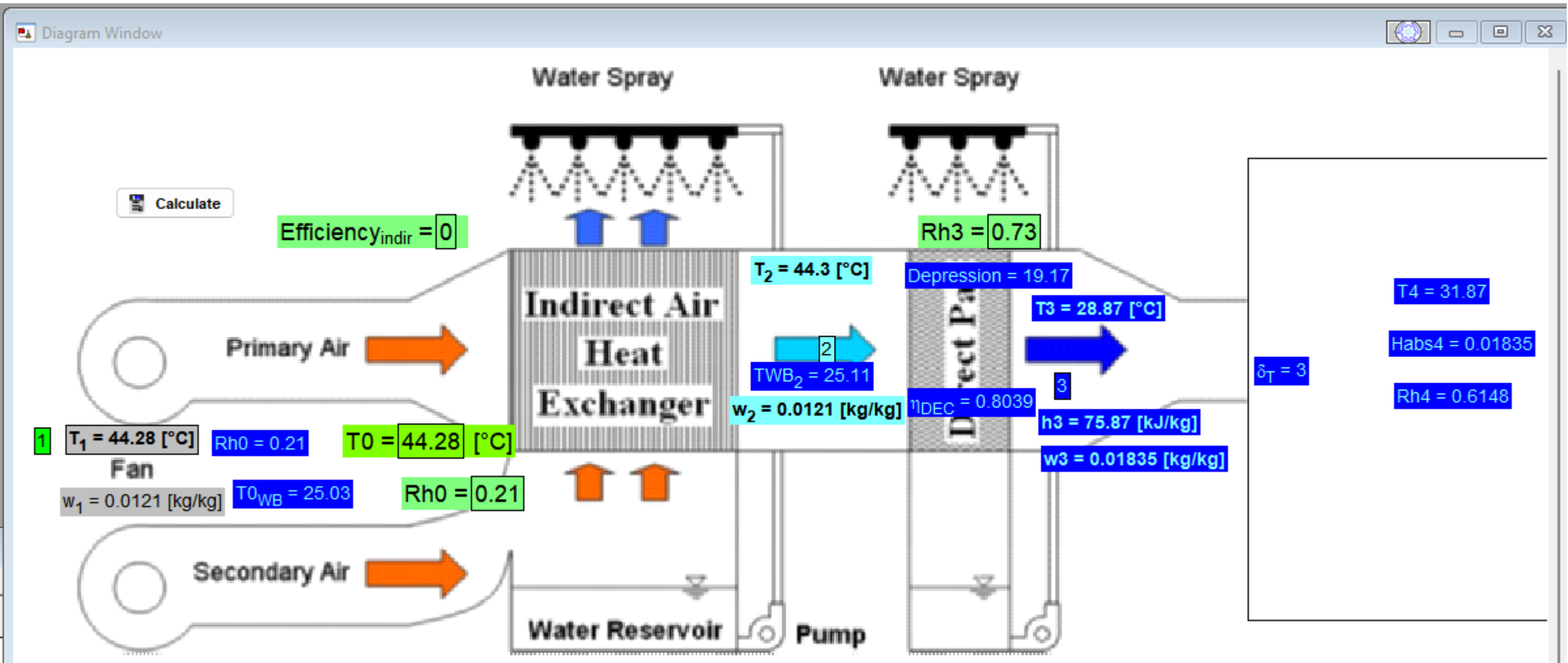
Heat transfer rates

12.40	0.00
12.40	8.362
0.00	0.00
12.91	73.99
12.00	0.01875





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Example with IDEC 60% and DEC evaporative cooling, 80 % efficiency (Delhi climate)

TRNEXE: C:\Trnsys17_2_0004\Projects\Evaporative cooling BeCool\261013 Delhi_ 260709 260310 AHU_IDEC_Swamp_combined_6d_house.dck

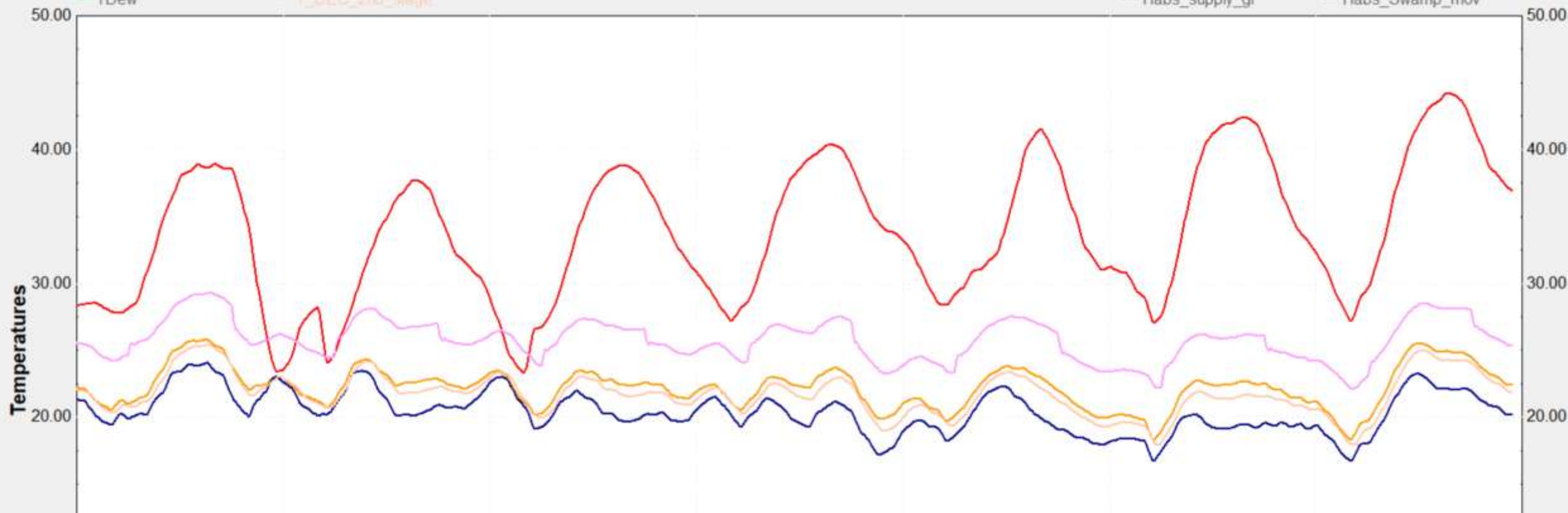
Calculations Plot Options About

Temperatures

- TDB dry bulb
- T IDEC 1st stage
- T supply DOAS
- TWB wet bulb
- TDew
- Delta T cool on
- TAIR_ZONE_A1
- TDew supply
- TWB after IDEC
- T_IDEC_2nd_stage

Heat transfer rates

- Habs ext gr
- Habs IDEC gr
- label
- Habs HXenthalp q
- Habs_supply_gr
- Q dot HX IDEC KW
- Qdot cool coil k
- Q dot HX IDEC KW
- Rh Swamp mov
- Habs_Swamp_mov





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TRNEXE: C:\Trnsys17_2_0004\Projects\Evaporative cooling BeCool\261013.Delhi_260709_260310_AHU_IDEC_Swamp_combined_6d_house.dck

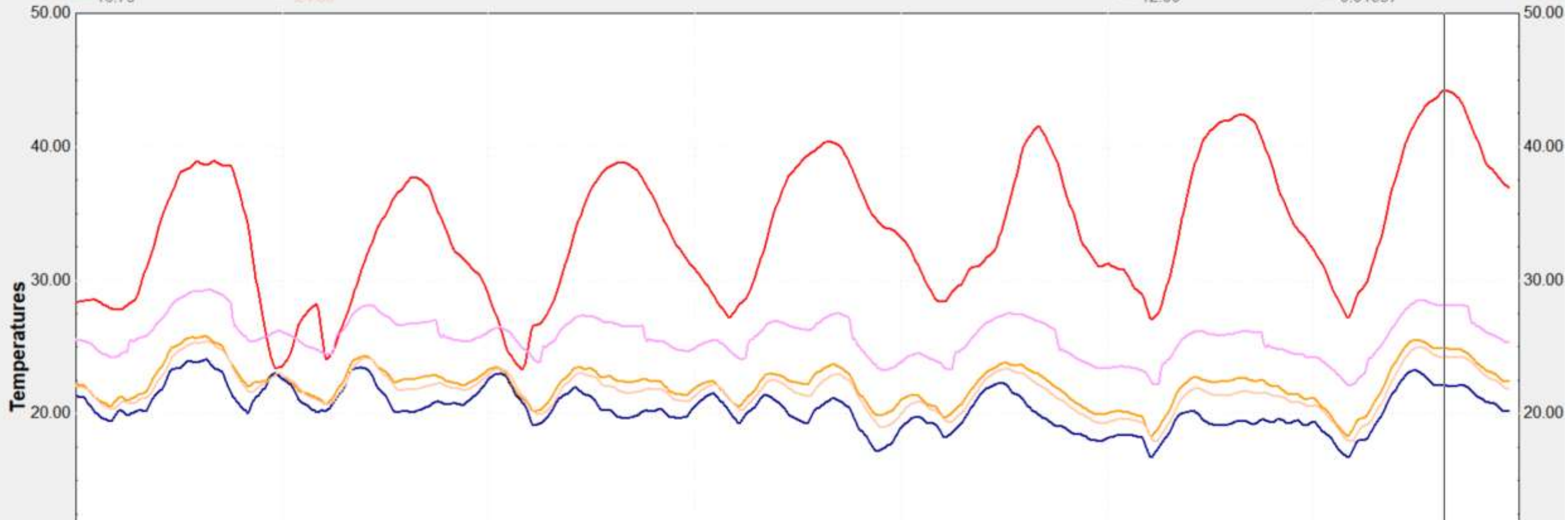
Calculations Plot Options About

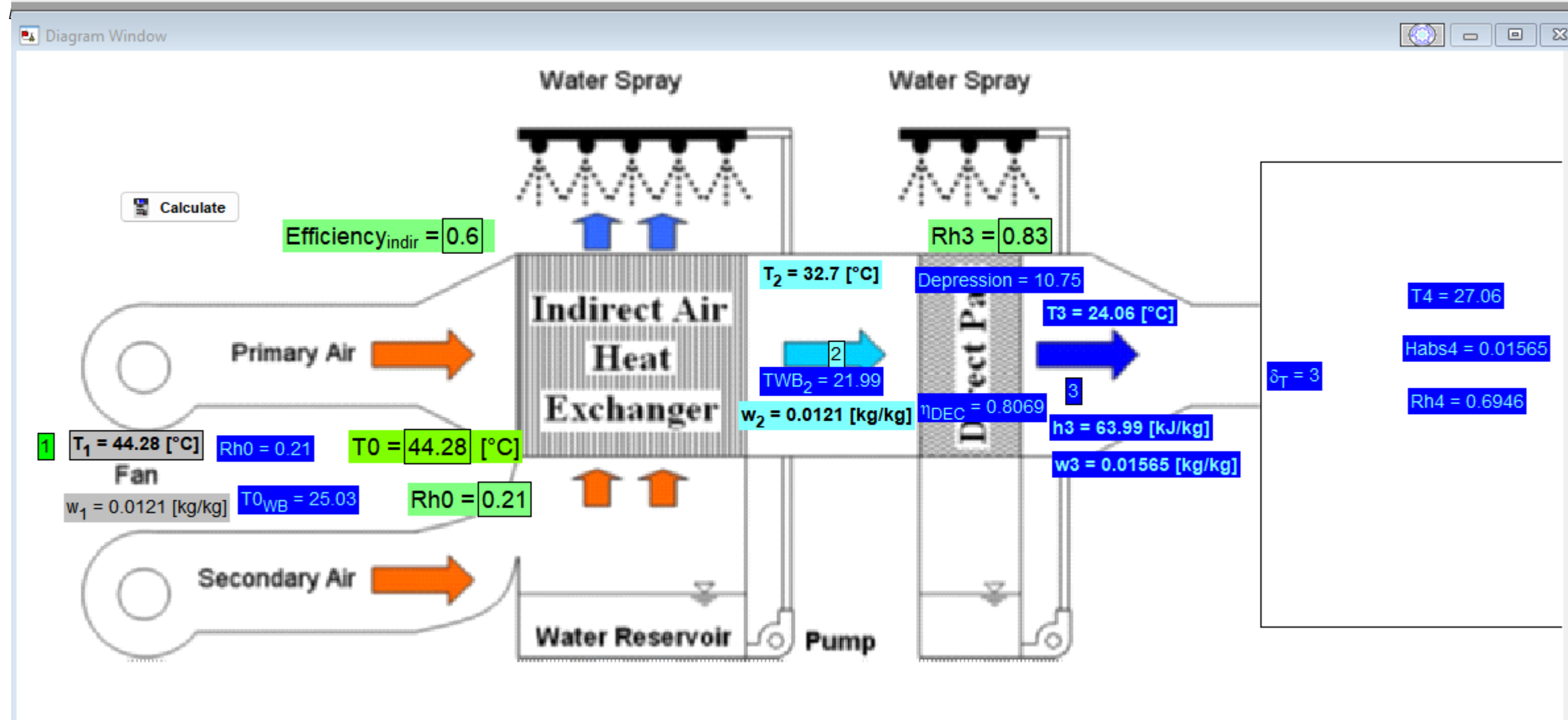
Temperatures

44.28	6.852
32.85	28.14
26.00	16.86
24.98	22.18
16.79	24.30

Heat transfer rates

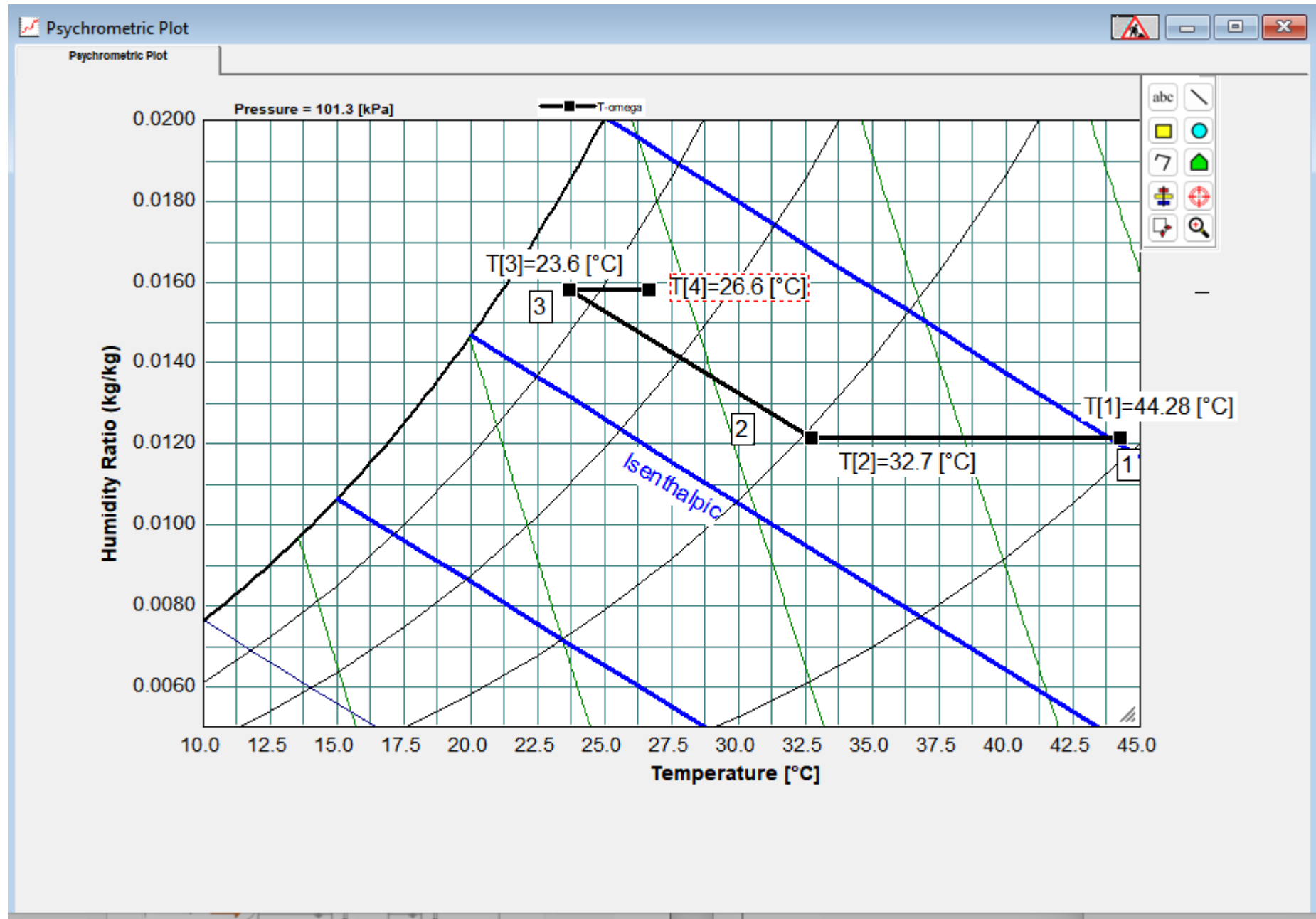
12.40	5.841
12.40	7.197
0.00	5.596
12.91	83.45
12.00	0.01597





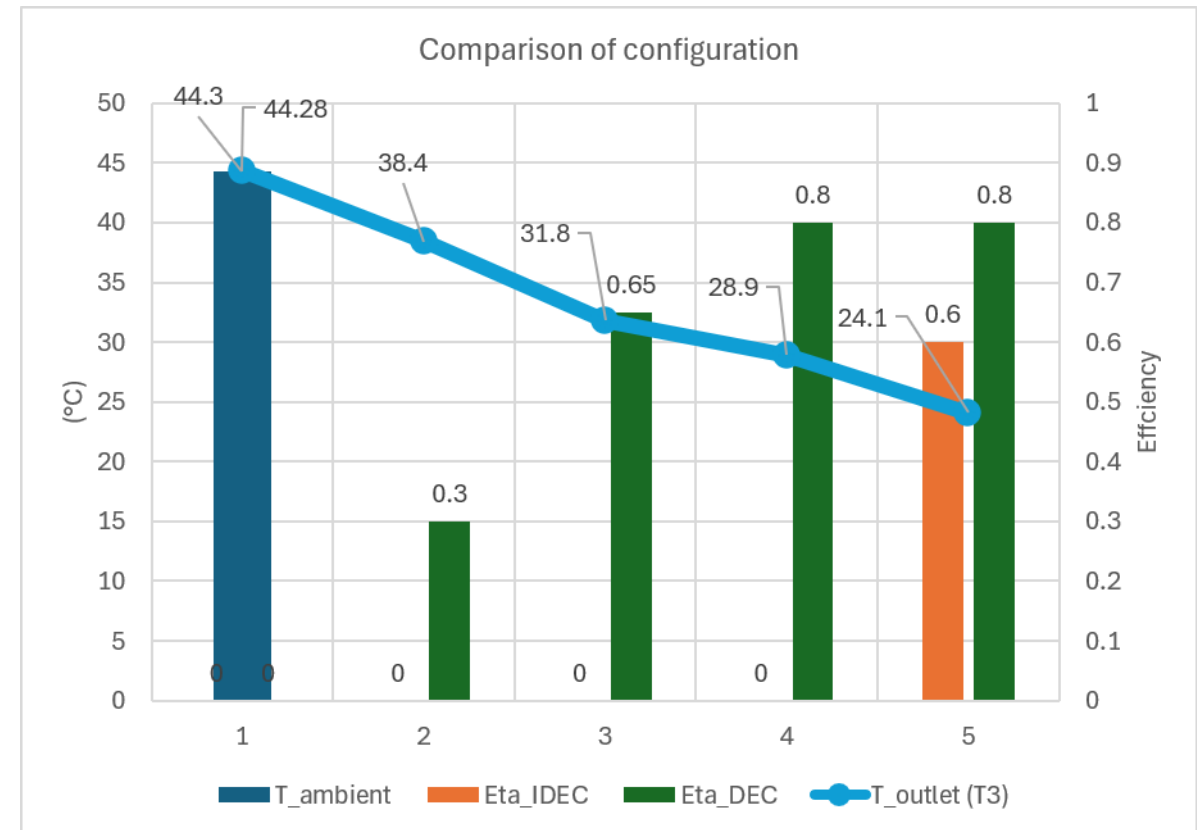
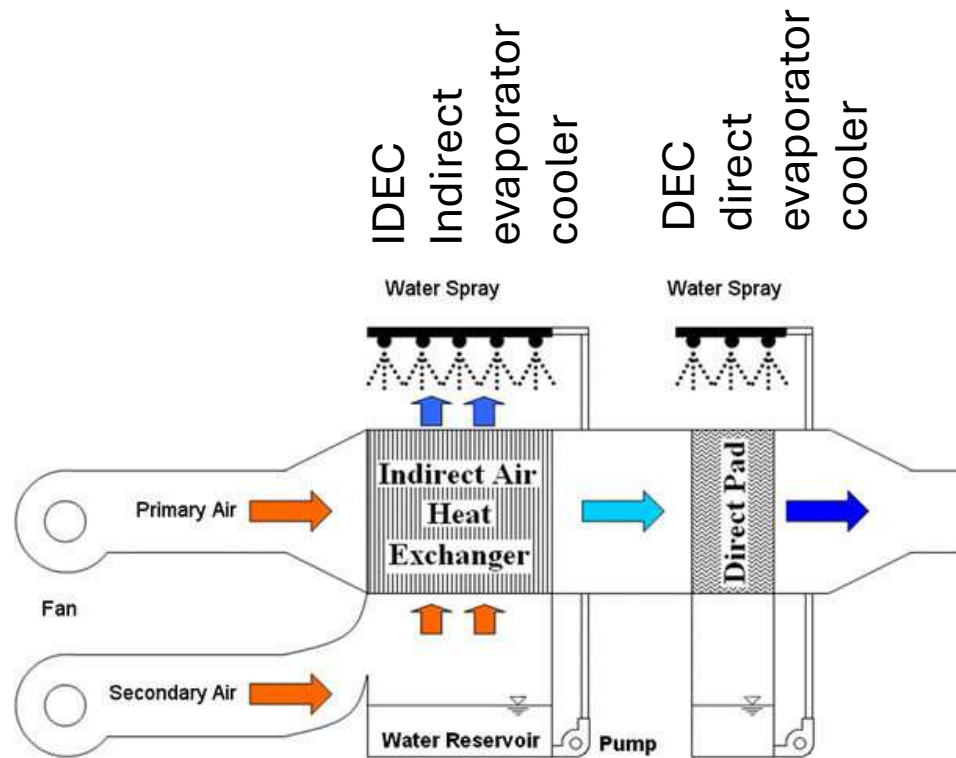


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IDEC and DEC combination and performance

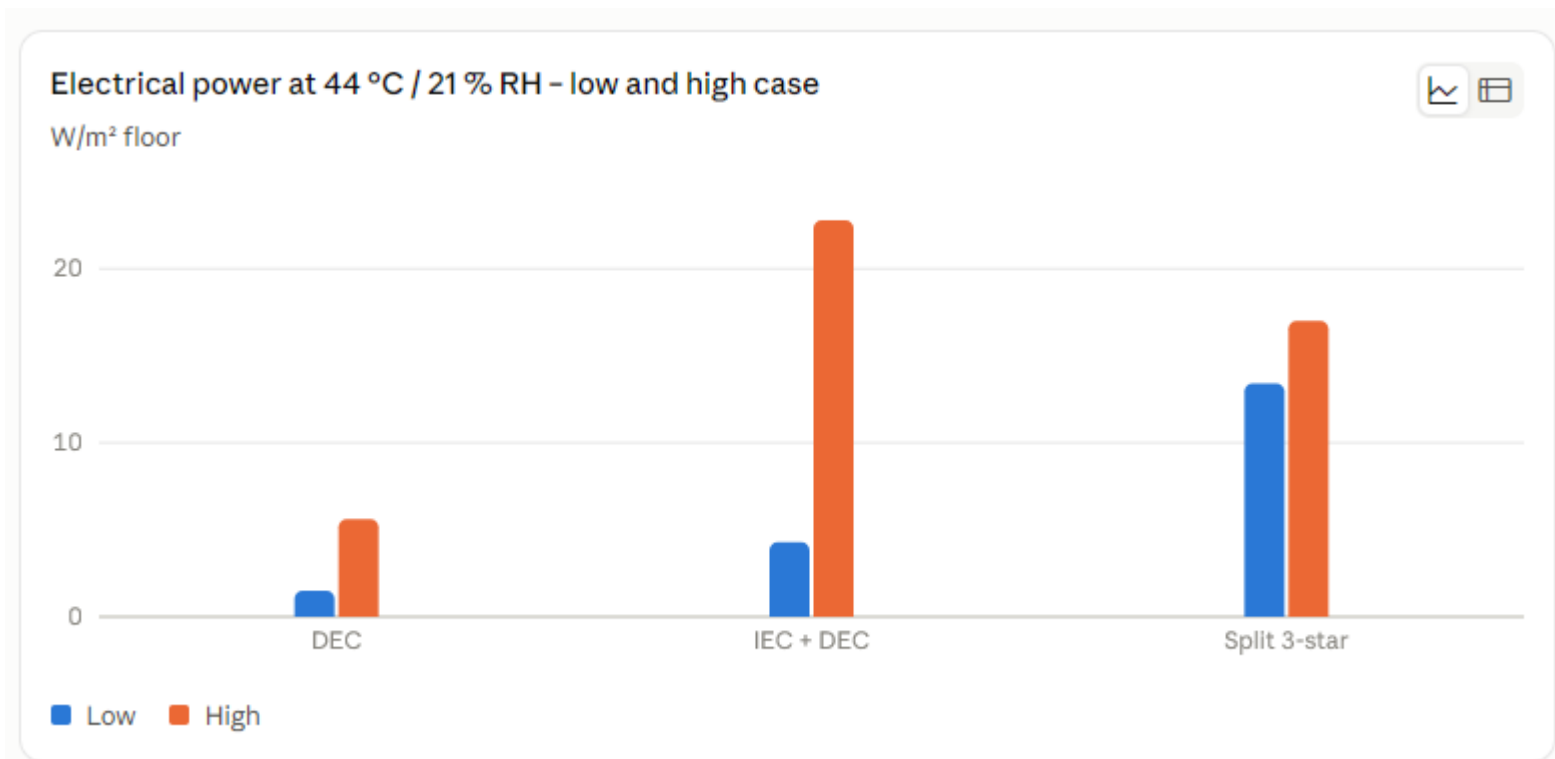




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Typical ratio of W/m² power at peak

- Super efficient direct evaporative cooling → 1.5 W/m²
- Worst design IEC+DEC → 23 W/m²
- Split AC → 13.4 – 17 W/m²



Electrical power at 44 °C / 21 % RH - low and high case

W/m² floor

Category	Low	High
DEC	1.5	5.6
IEC + DEC	4.3	22.8
Split 3-star	13.4	17



Affordable housing example

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□ Energy
Efficiency

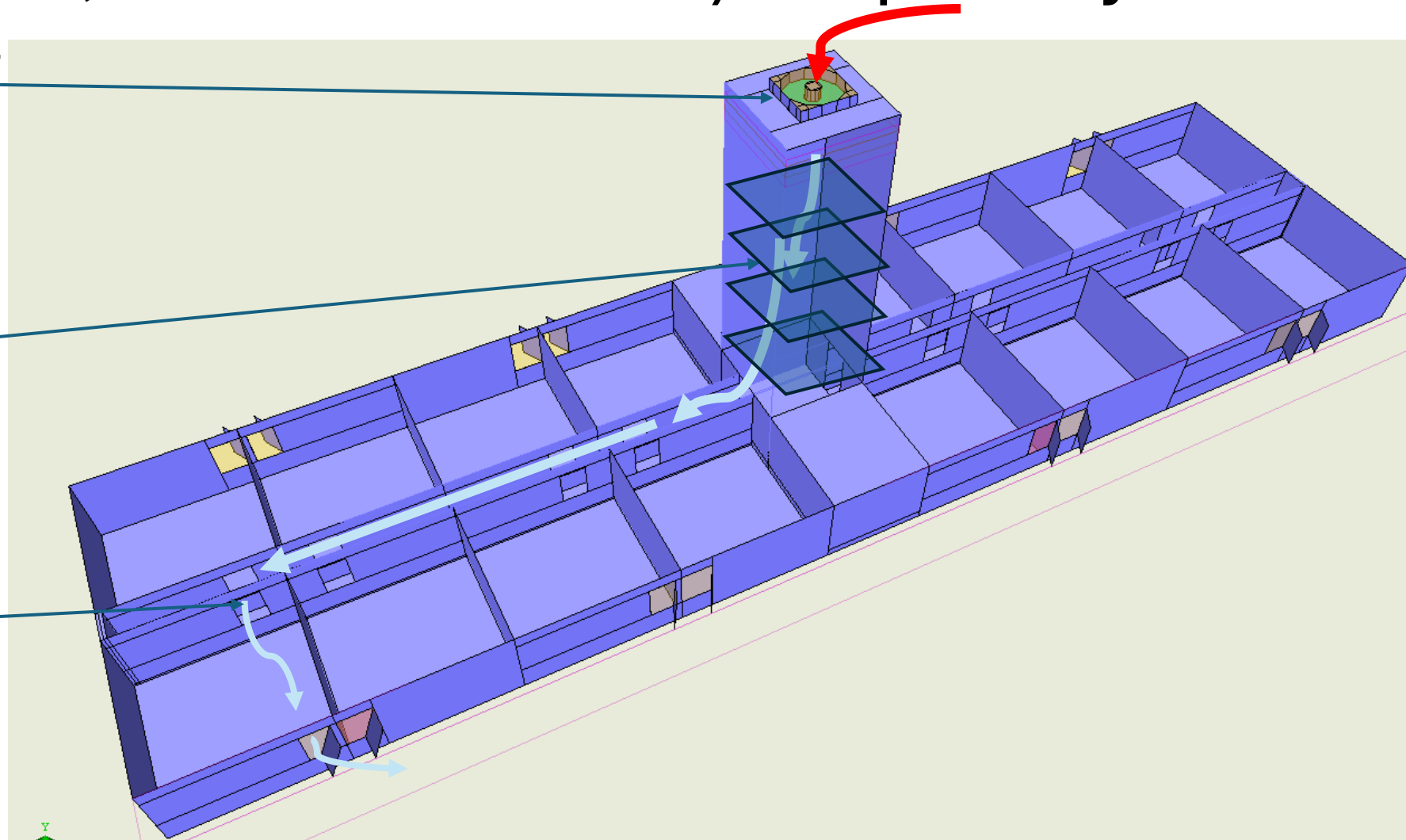
- Multi-storey
- Long buildings





Principle of retrofit for centralised down draught evaporative cooling (example showing from roof to the lowest floor, others not shown) simplest system

- Roof evaporative cooler (fan and high-pressure mist or evaporative cooling pad (then vertical plan))
- Central staircase shaft (5-6 floors)
- Air flow from roof through corridors and through flats
- Calibrated openings
- Lower floor presented (higher are similar)
- Each flat 6x6x3 m, corridors 1.2 m width

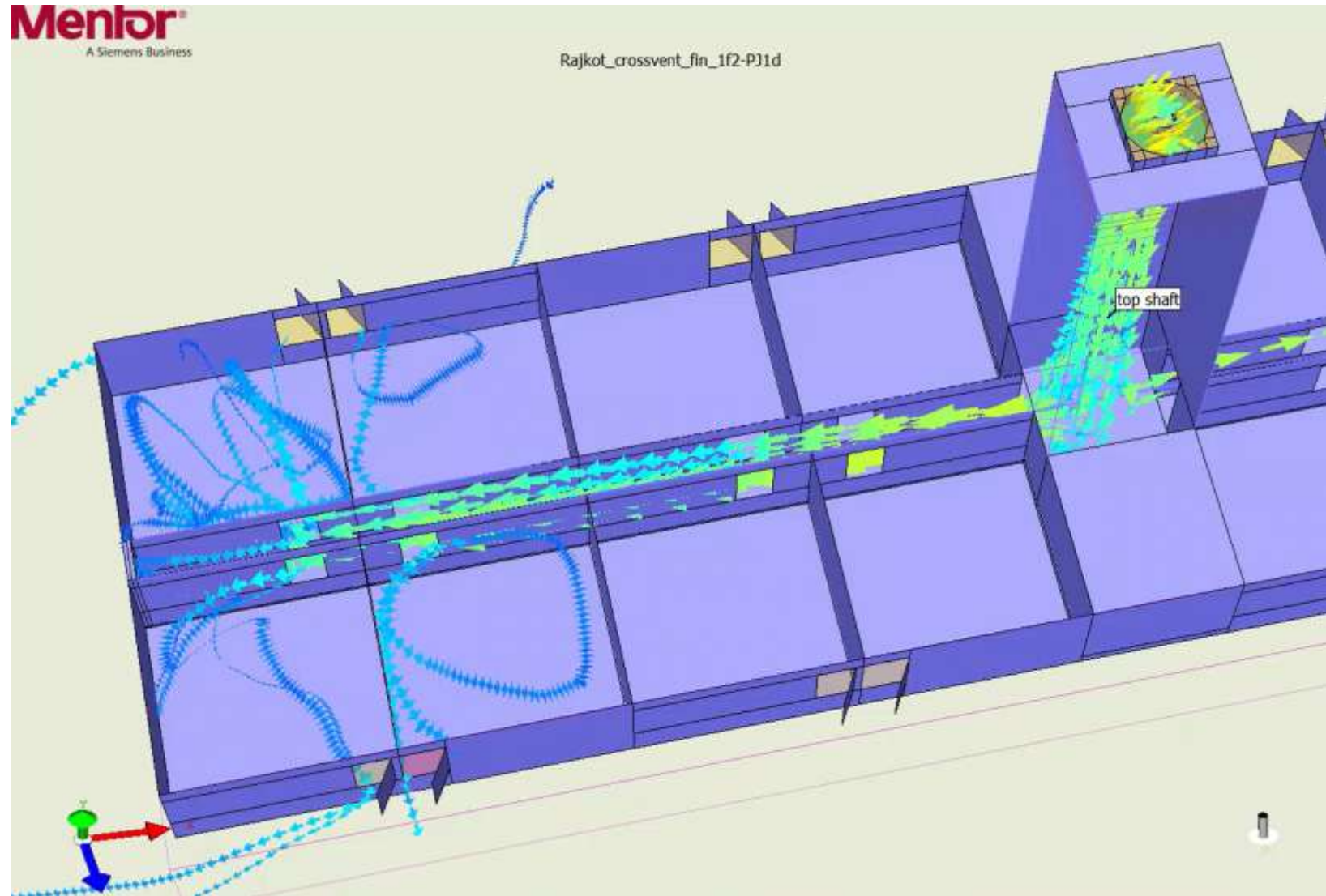




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Partial fiew of the air flow from roof to exhaust

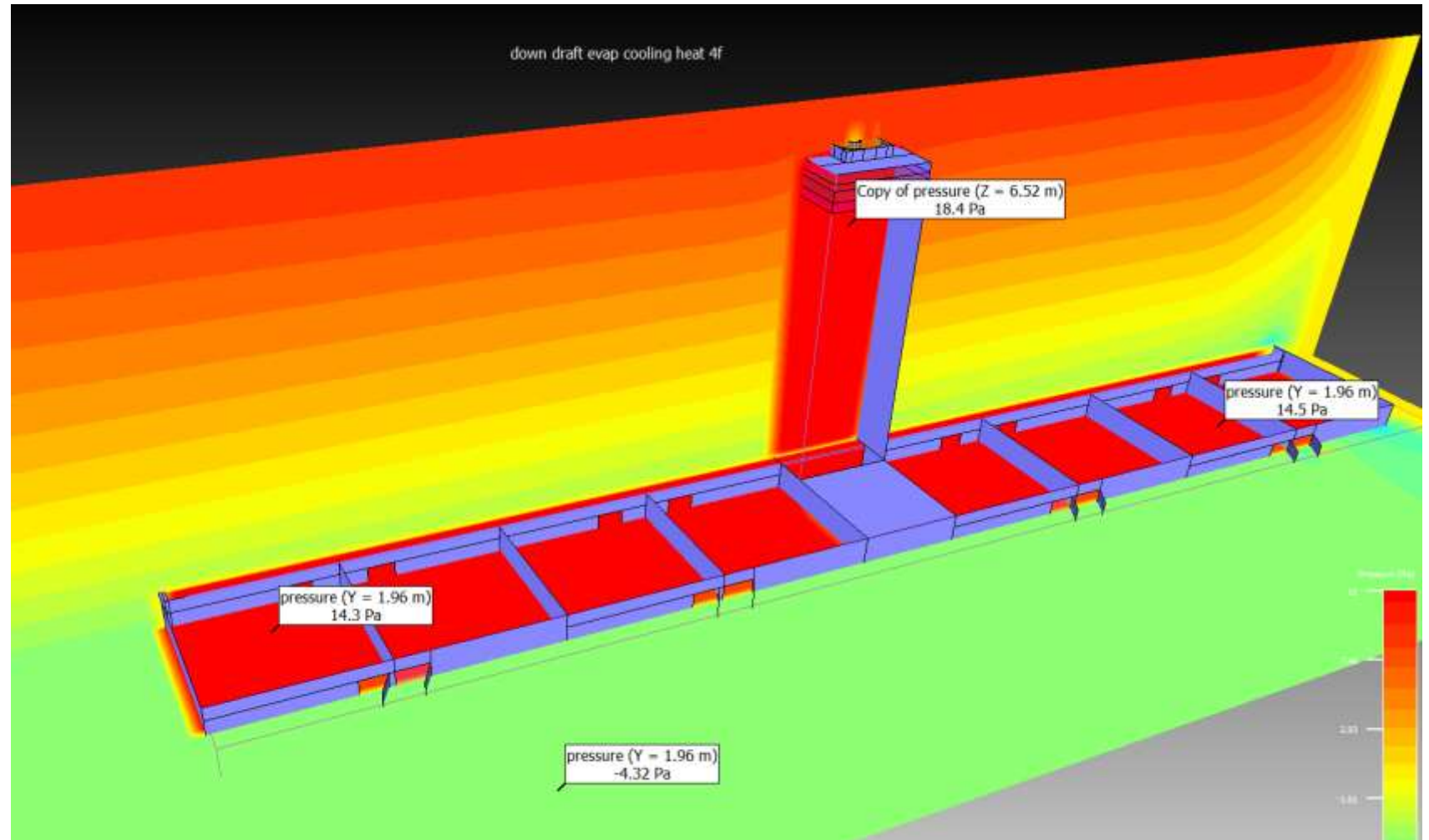
Oneflat	6m
	6m
	3m
	108m ³
Nber of flats	16
Total volume	1728m ³
Fan flow rate	5.76m ³ /sec
	20736m ³ /hr
equivalent to	12ACH





Pressure with minimal resistance at the entrance in the flats

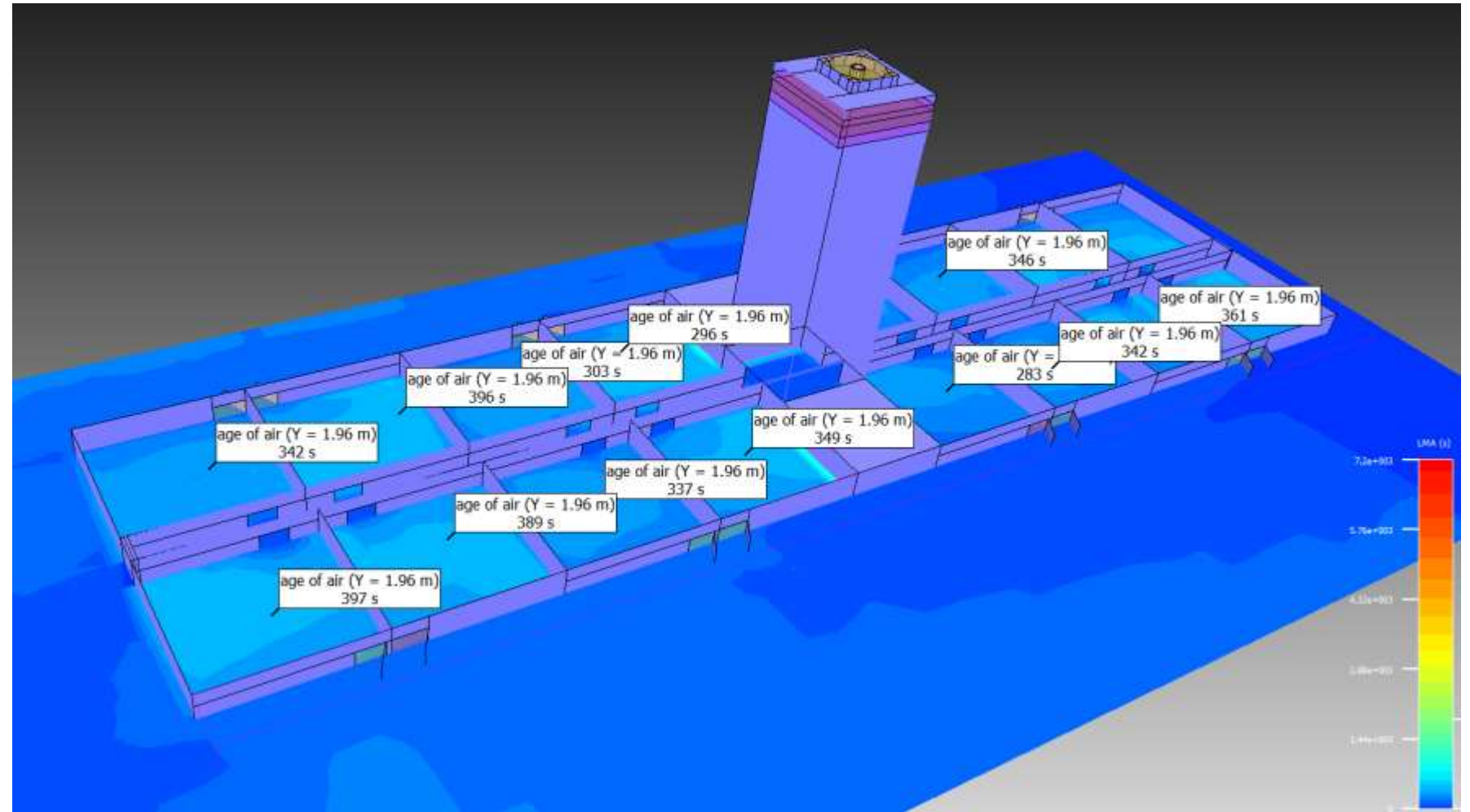
- Good pressure distribution





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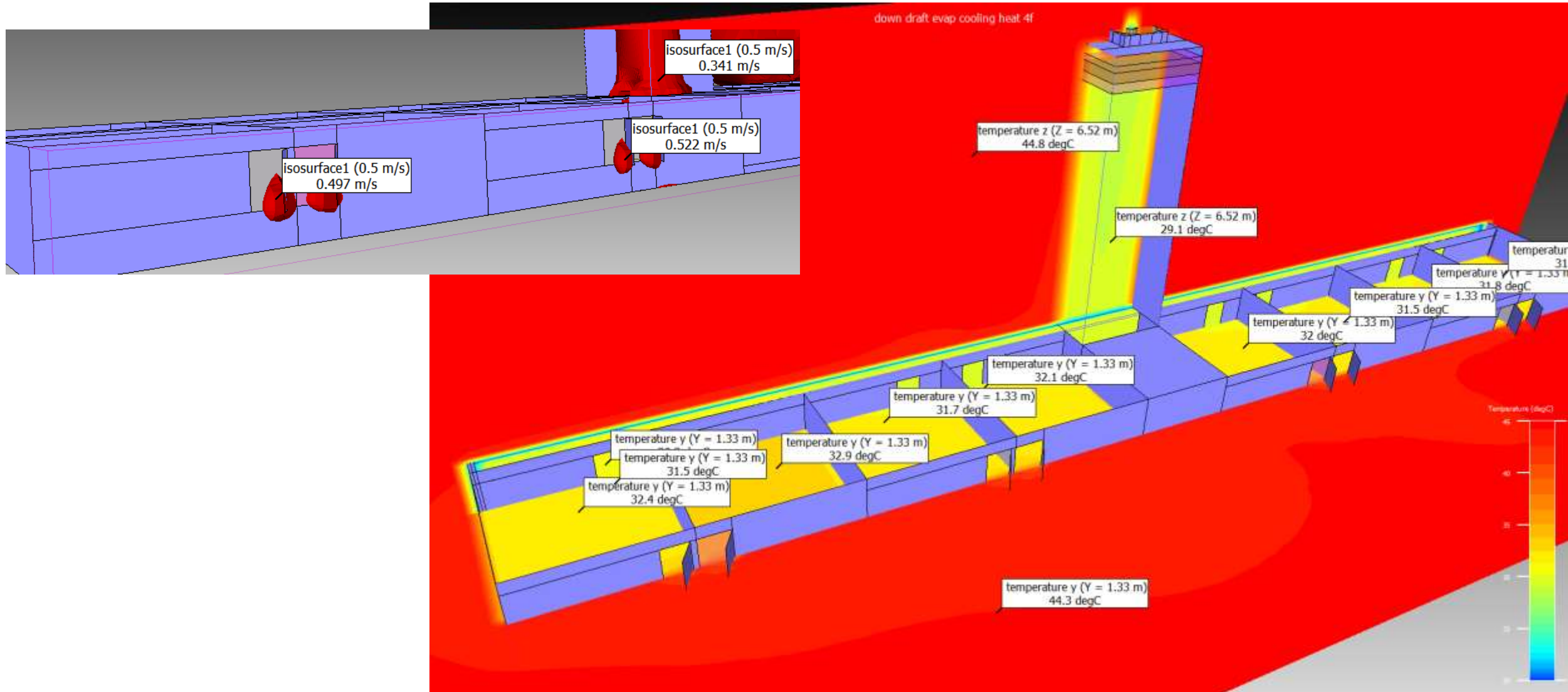
Age of air (12 ACH = 300 sec)





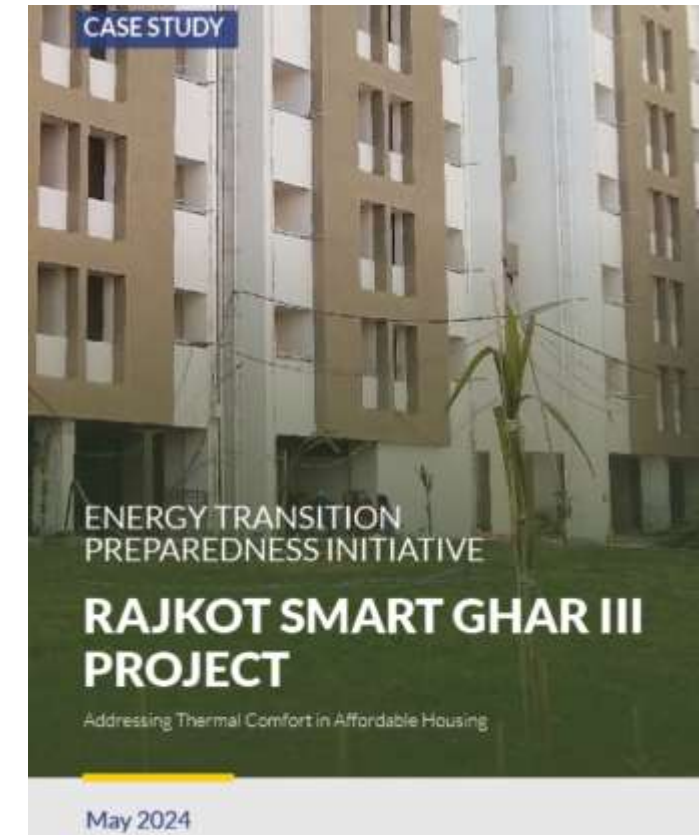
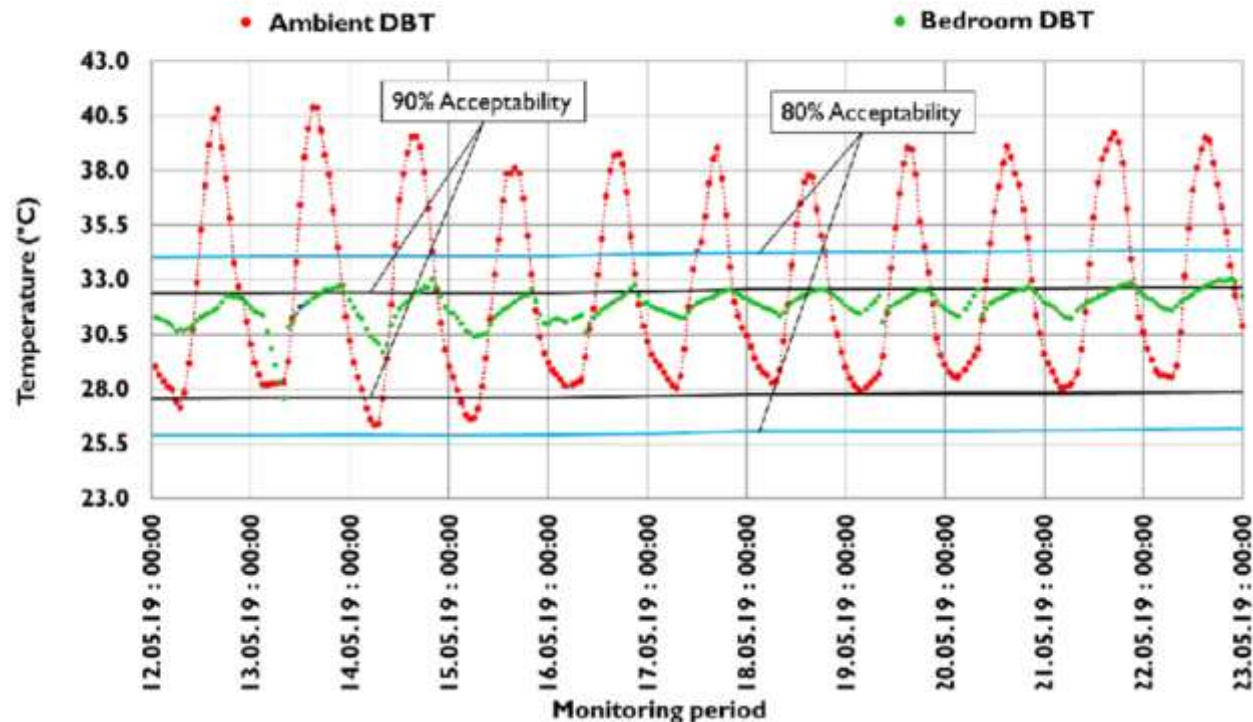
Good distribution of air exhaust between flats

Initially ~ surface temperature in flats at 33 °C



Experience in air flow distribution among flats in night cooling ventilation test

- No damper or mobile resistances
- Calibrated resistance





Real study and **testing** of a simple energy efficient ventilative cooling system

- **Real study and testing of a simple energy efficient ventilative cooling system**
- Test of simple and energy efficient ventilation system in a vertical shaft in the middle of 14 flats on 7 floors.
- The system is designed to draw in a balanced manner air from the flats with 12 air change per hour with a power of 1.3 W/m² of floor area. The ratio of power on flow rate is of 0.515 kW/3.89 m³/sec = 0.13 kW/(m³/sec). The numbers are the one measured on site.



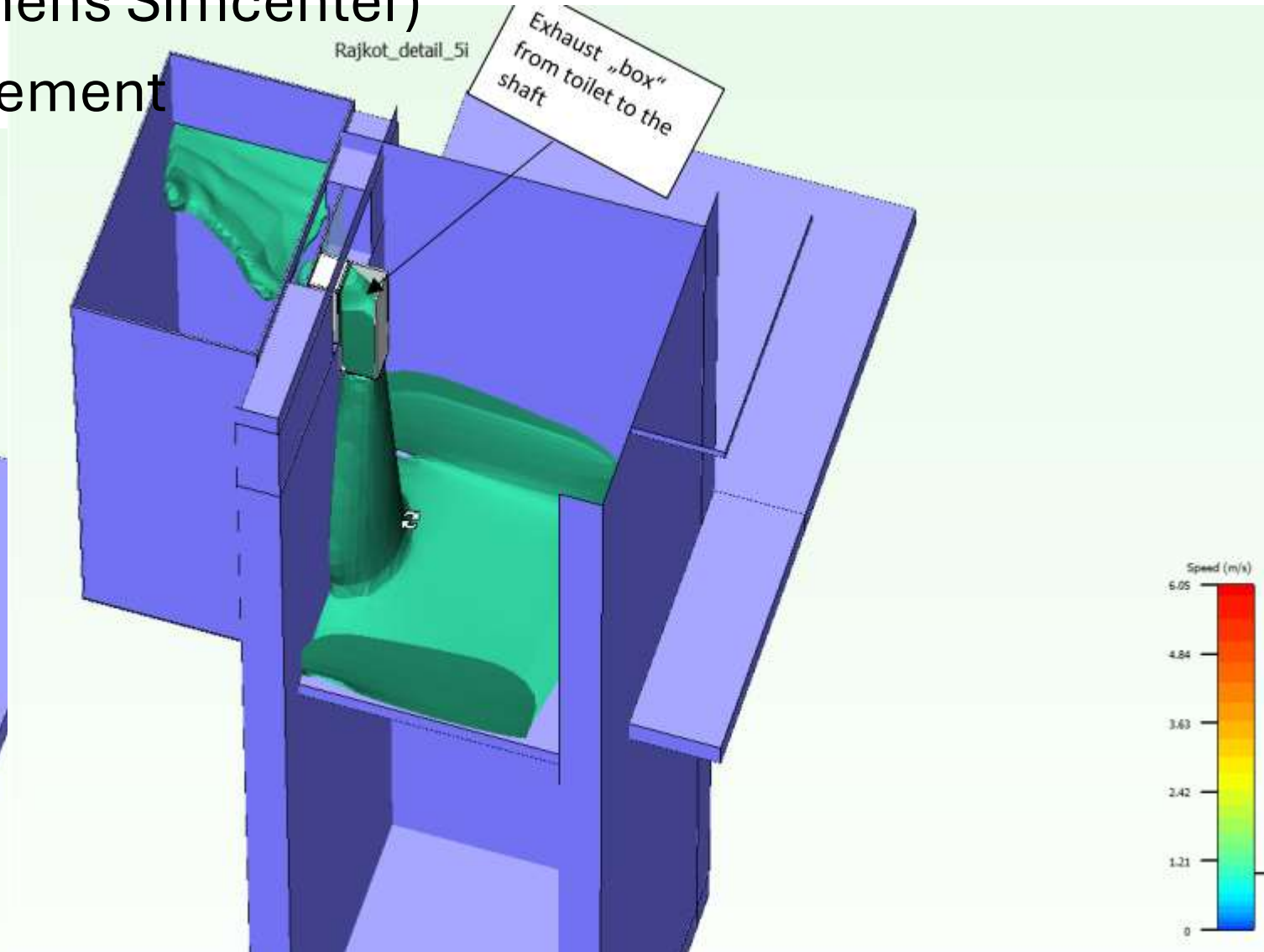
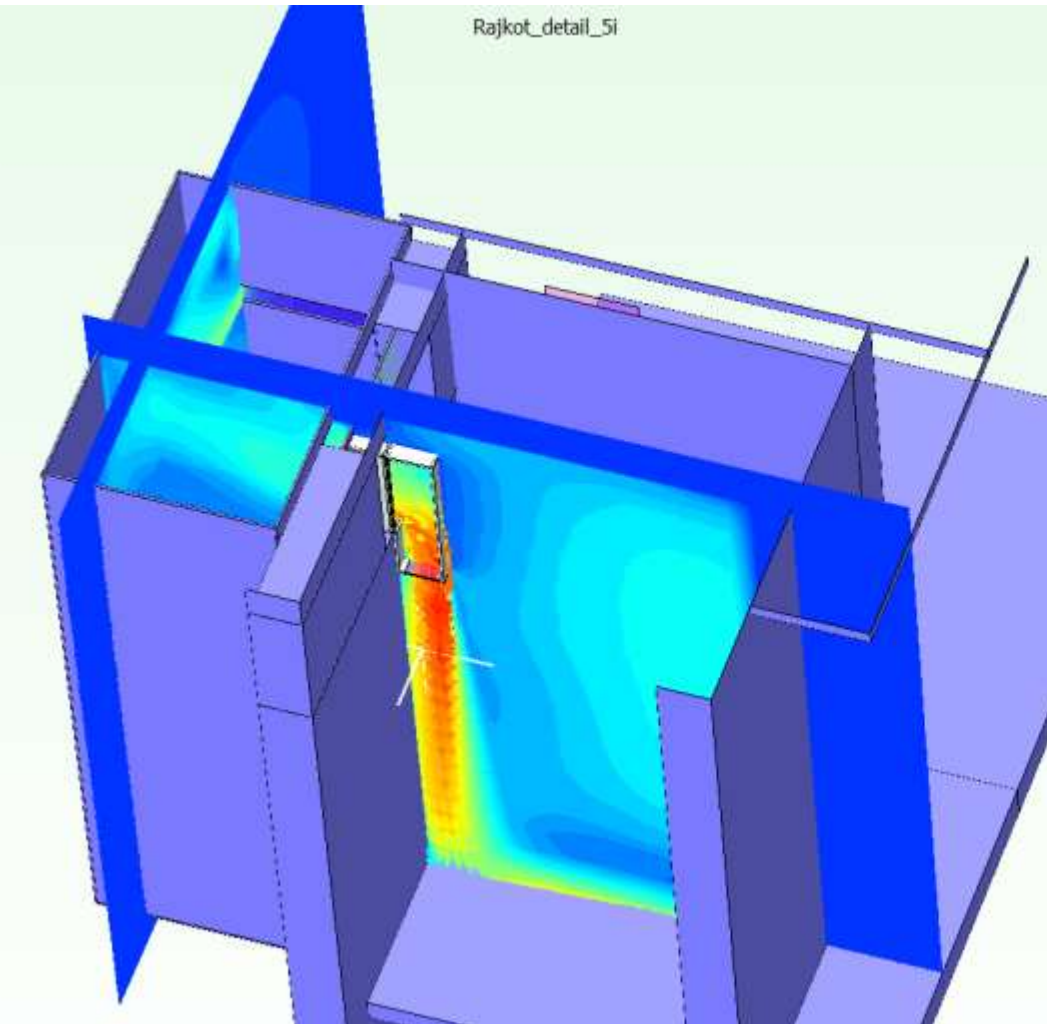
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Central Ventilative cooling

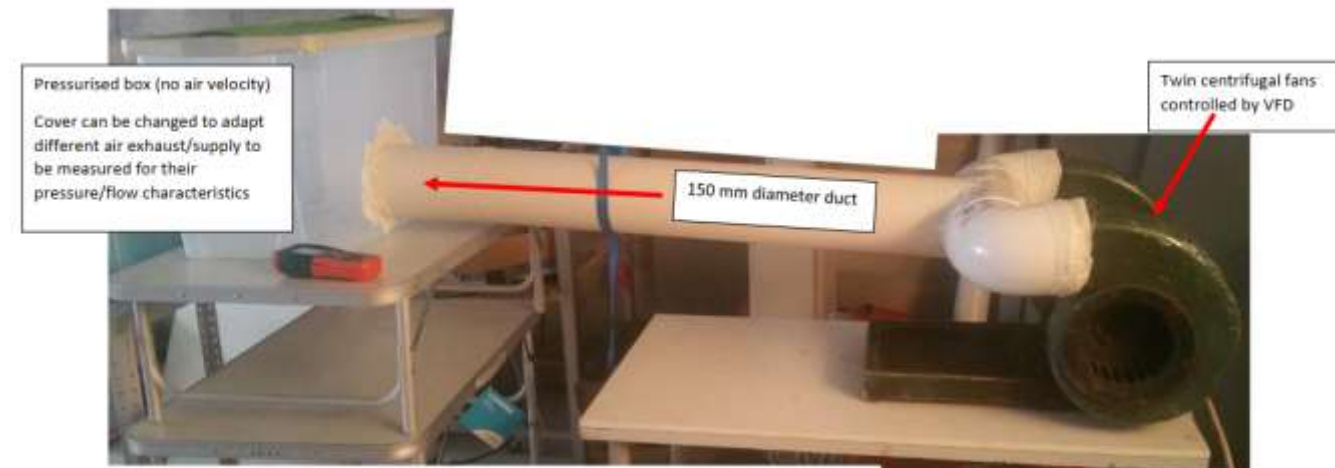
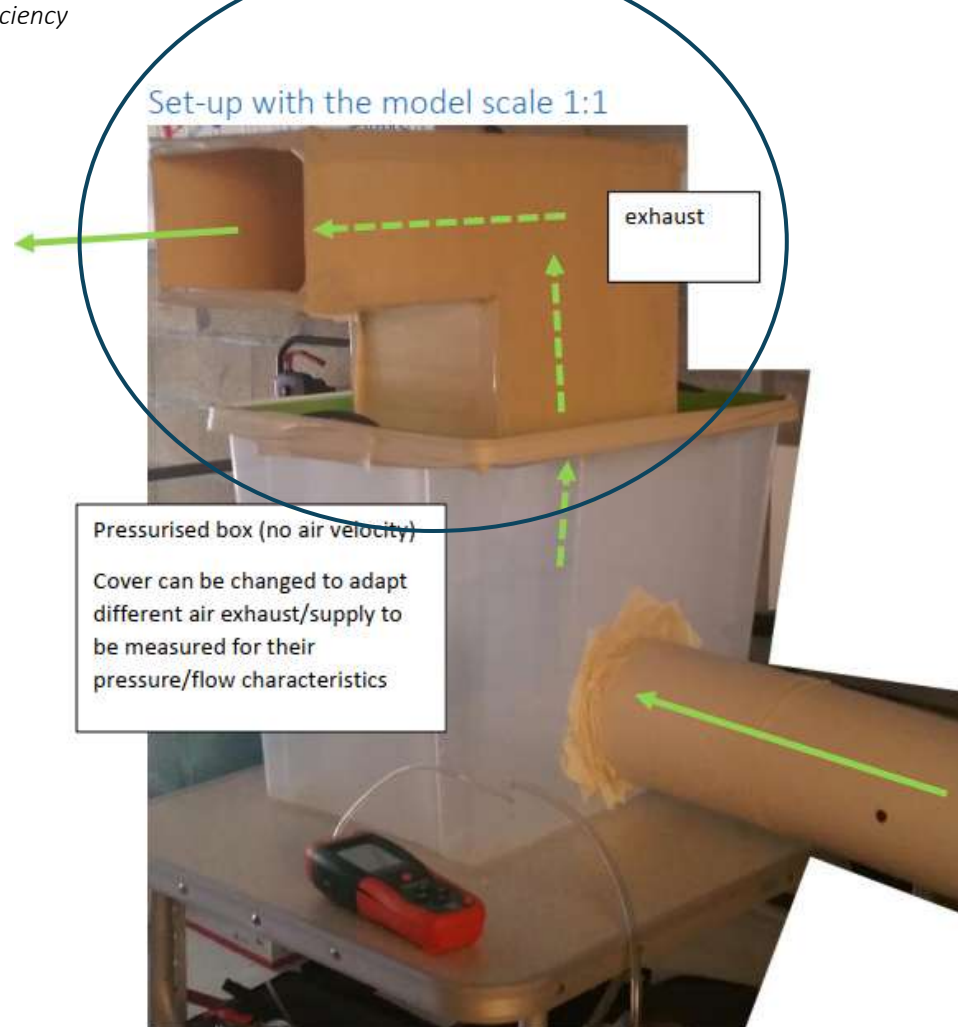
- CFD design (Flovent Siemens Simcenter)
- Design of the resistive element



GREENTECH KNOWLEDGE
SOLUTIONS PVT. LTD



Night ventilative cooling





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Example of the Rajkot Smar Ghar centralised exhaust for ventilation across the windows of each flat (should be reverse of downdraft evaporative cooling)



Natural Ventilation Potential and use of Computational Fluid Dynamics (CFD) in Residential Buildings

Vayu Pravah वायु प्रवाह

Free software for the simulation of wind driven air movement around and inside buildings

Version 2



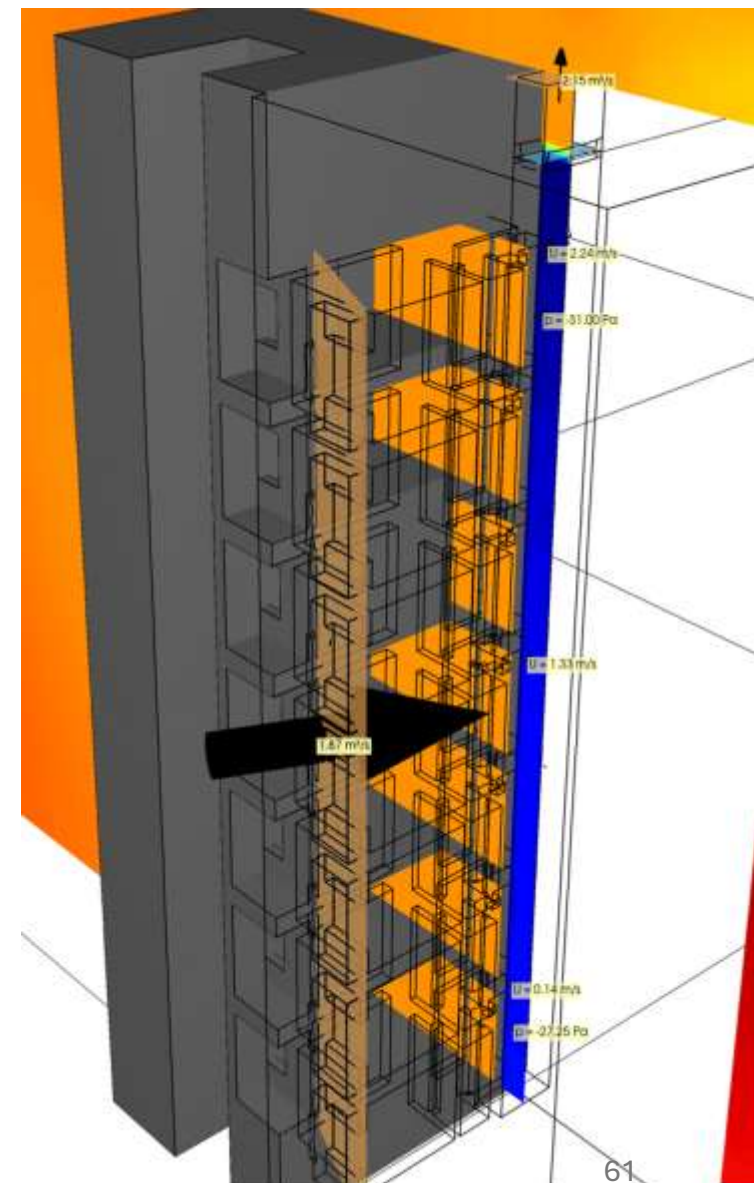
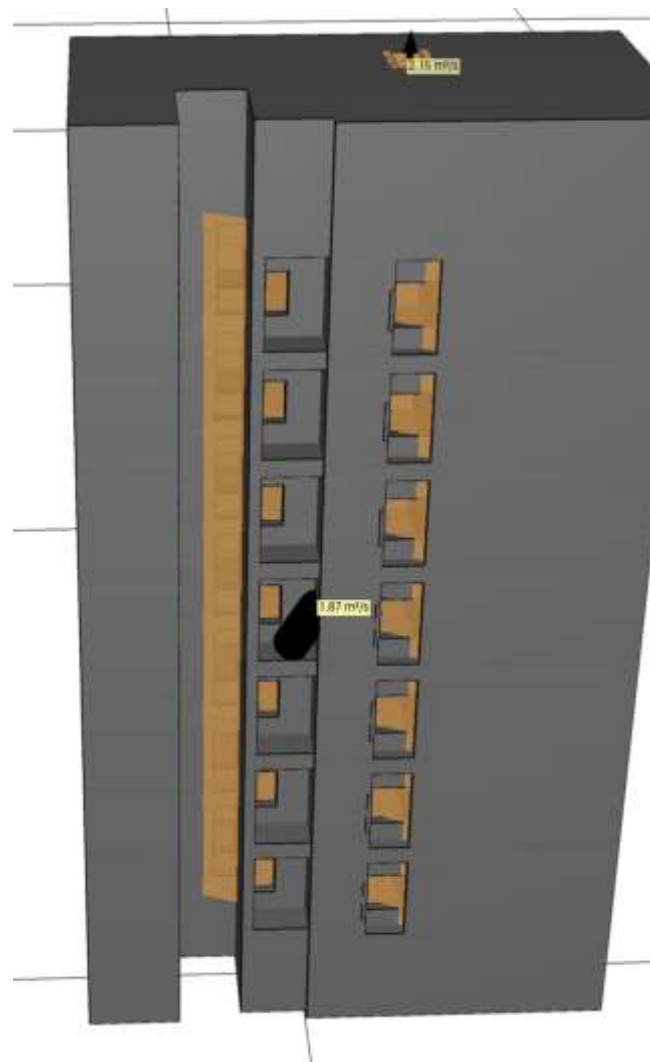
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development
and Cooperation SDC





- # Ventilative cooling
- Modelling with Vayu Pravah
 - 7 flats with the corresponding system
 - A fan which generates a pressure jump of 30 Pa
 - Calibrated exhaust to the shaft for 30 Pa pressure loss
 - Total air flow: 7200 m³/h





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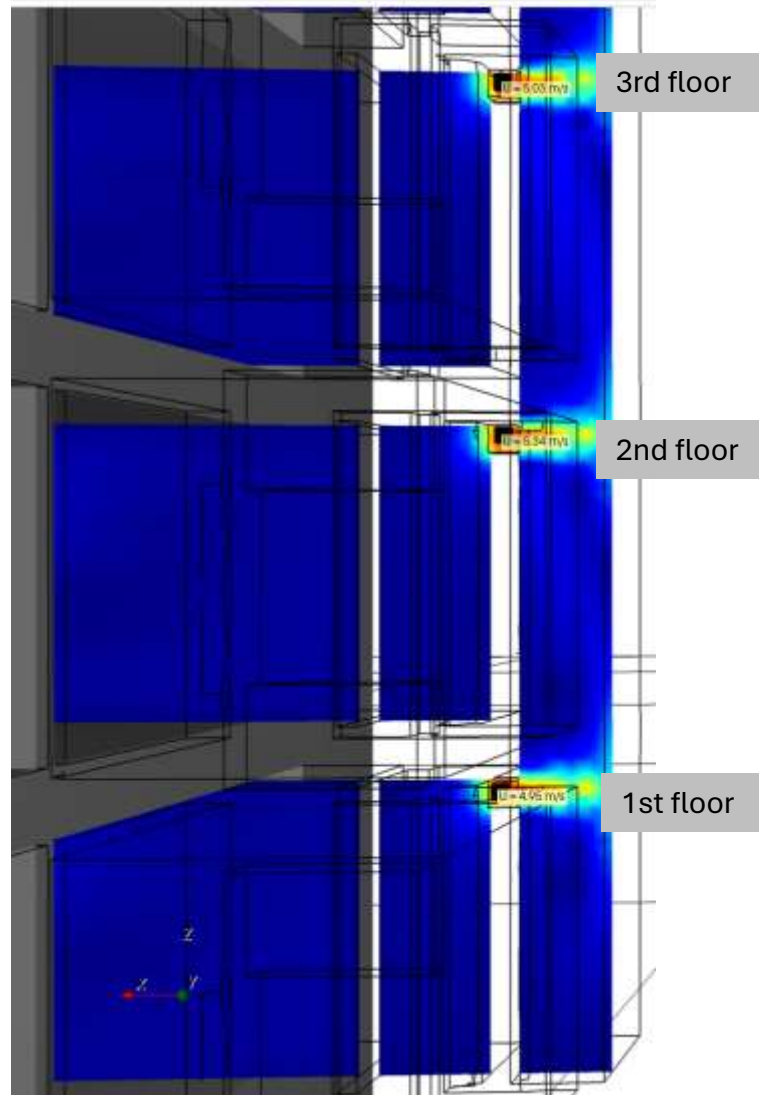
Ventilative cooling



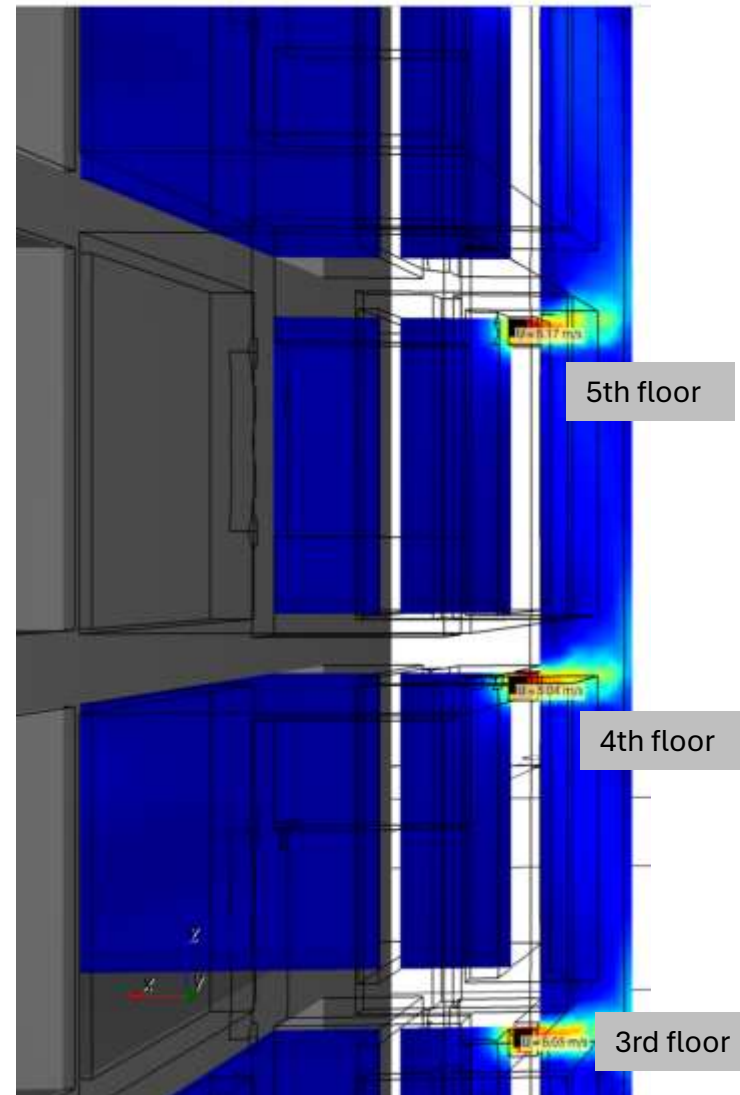
GREENTECH KNOWLEDGE
SOLUTIONS PVT. LTD



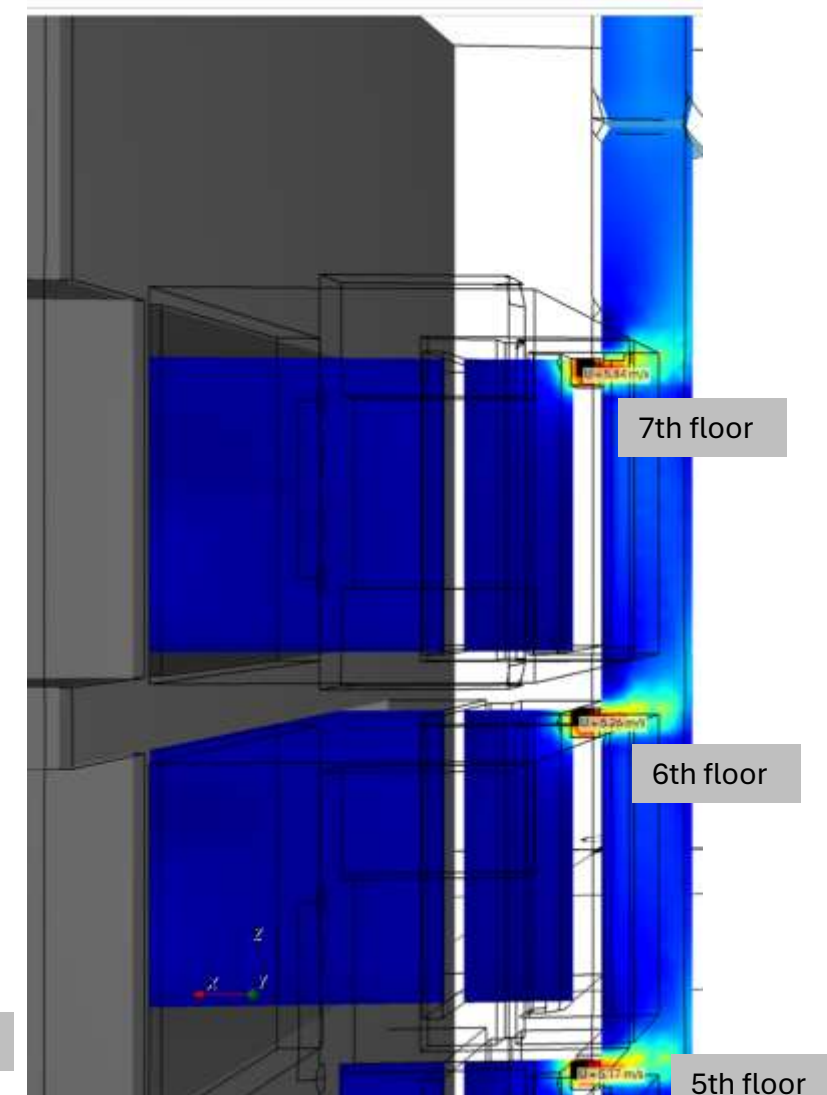
Rajkot ver 18



Rajkot ver 18

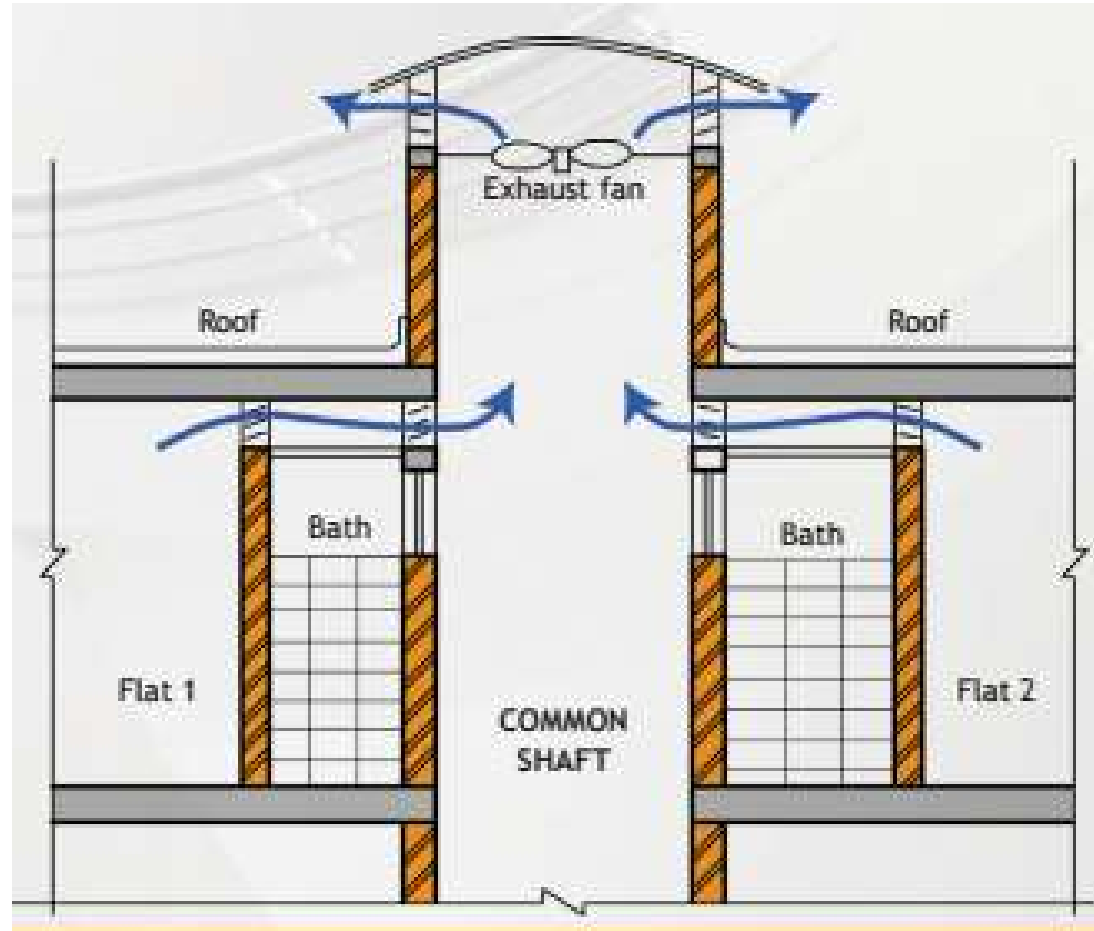


Results run: Rajkot ver 18



Additional assisted night ventilation (no evaporative cooling but down draught can be done in a similar manner)

A fan on top of the service shaft can provide additional ventilation through flats, to cool the flats during night when the ambient temperatures is low.

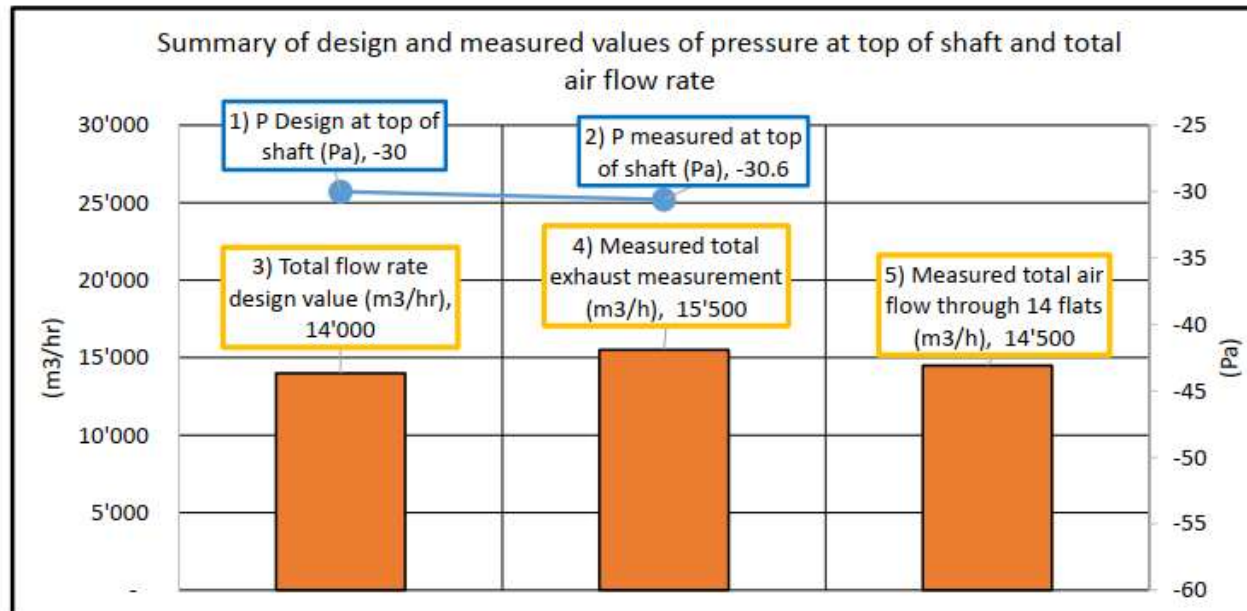
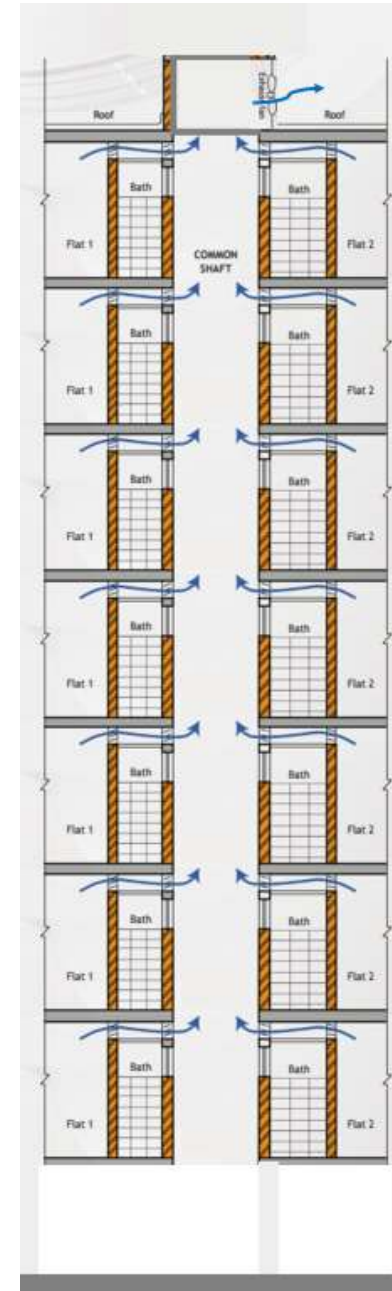
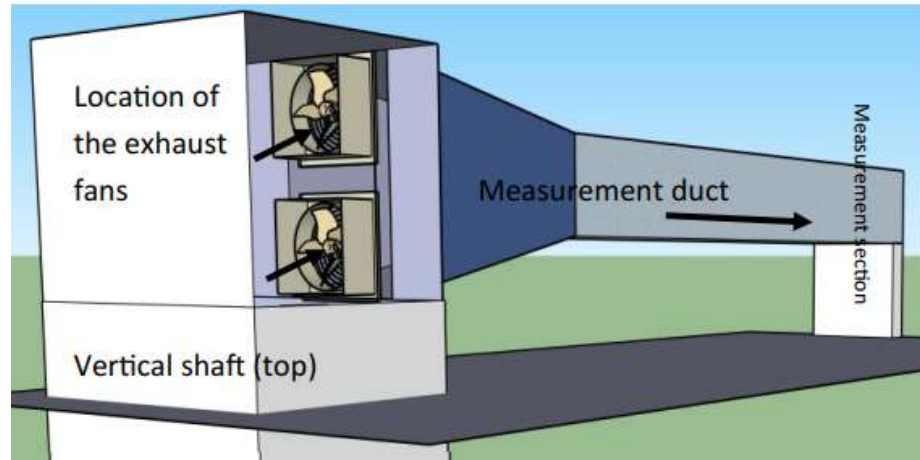




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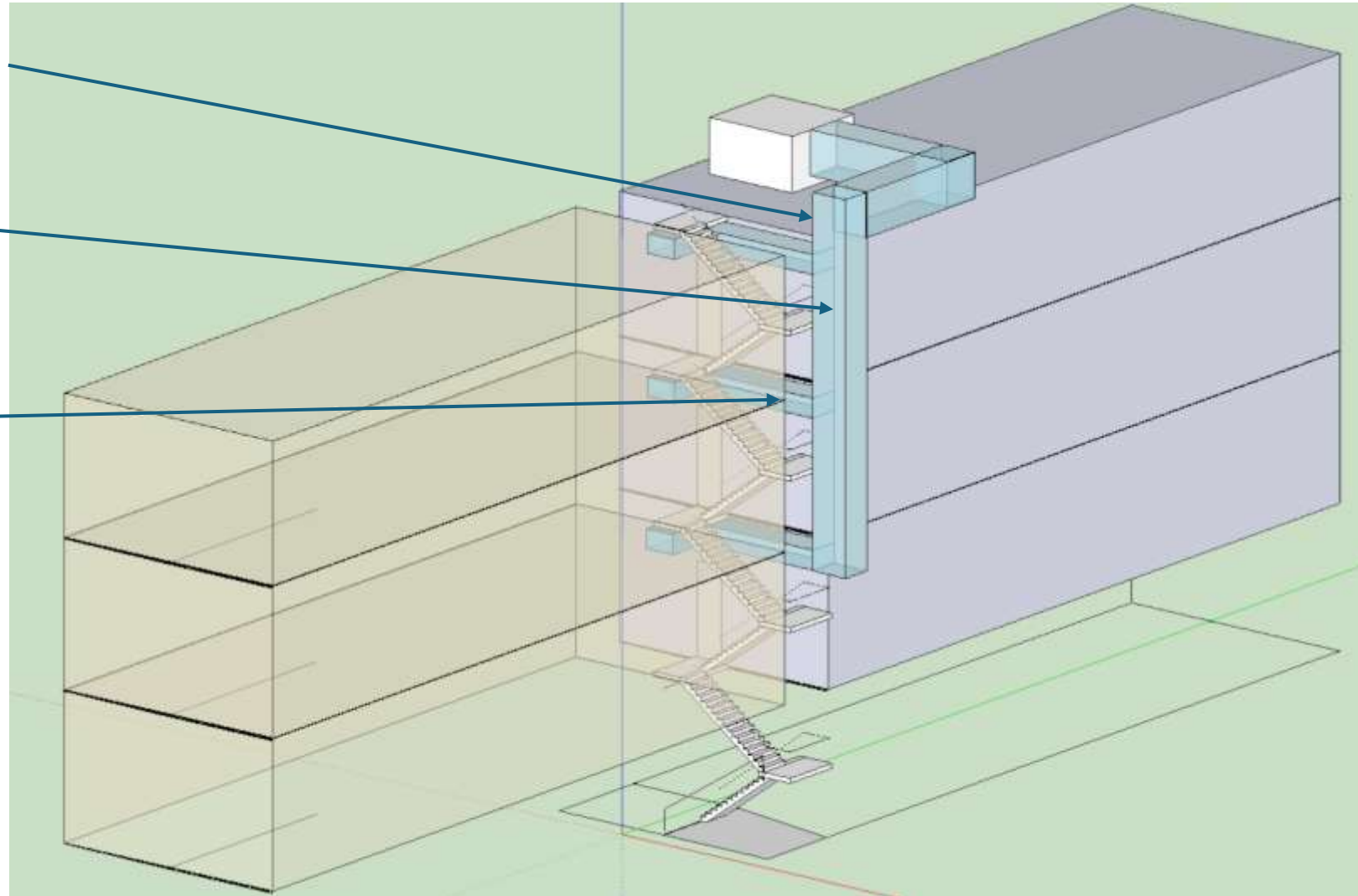


Ventilative cooling actual test results (Smart Ghar 3, Rajkot)



Central Evap Cooling: solution for an affordable housing with central stair case

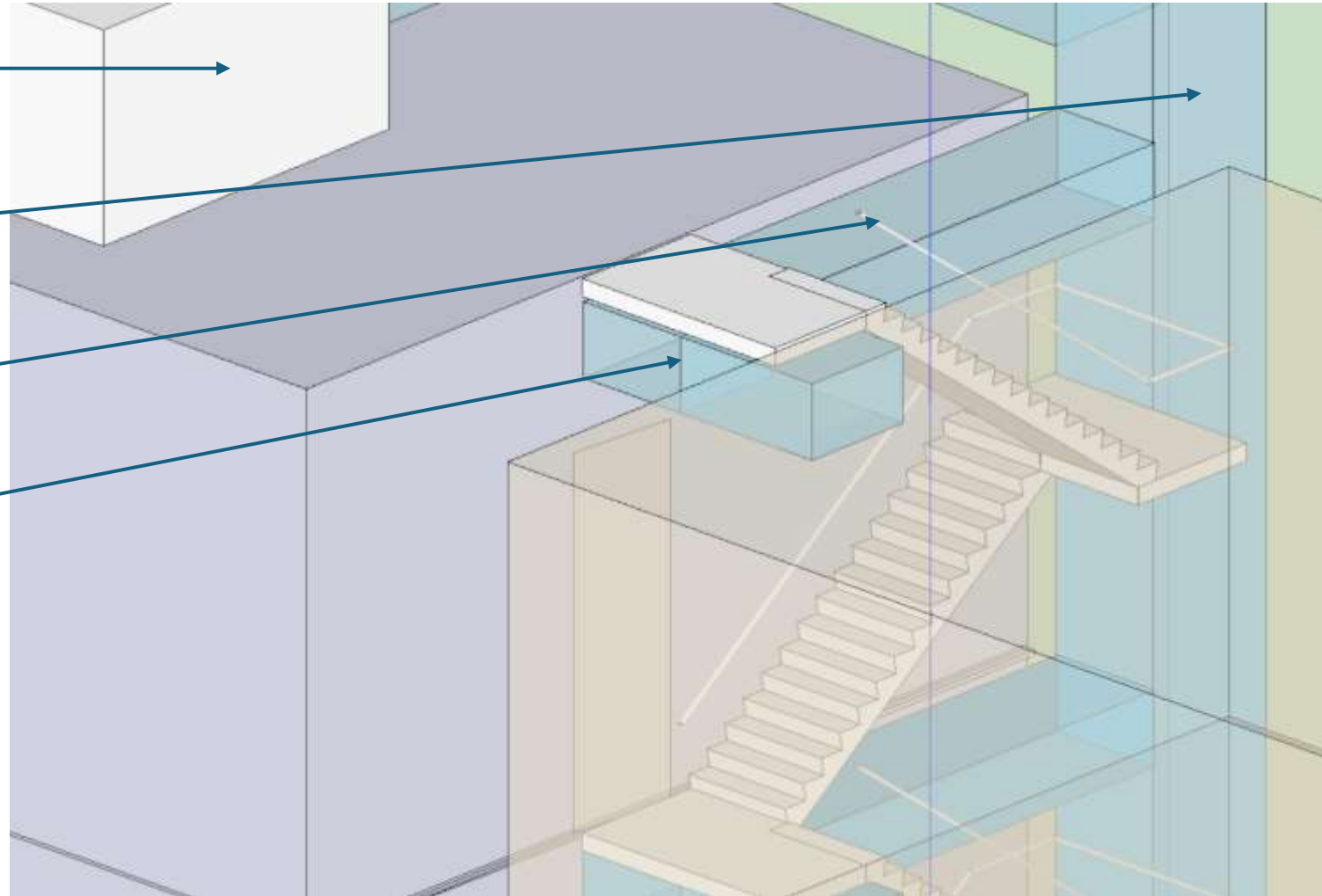
- Evaporative central on the roof
- Vertical duct along the façade
- Horizontal ducts in the stair case
- Supply to each floor (2 sides)
- Conditions closing the end of corridor
- Closing the entrance door





Solution for an affordable housing with central staircase integration example

- Evaporative central on the roof
- Vertical duct along the façade
- Horizontal ducts in the stair case
- Supply to each floor (2 sides)
- Conditions closing the end of corridor during operation
- Closing the entrance door during operation

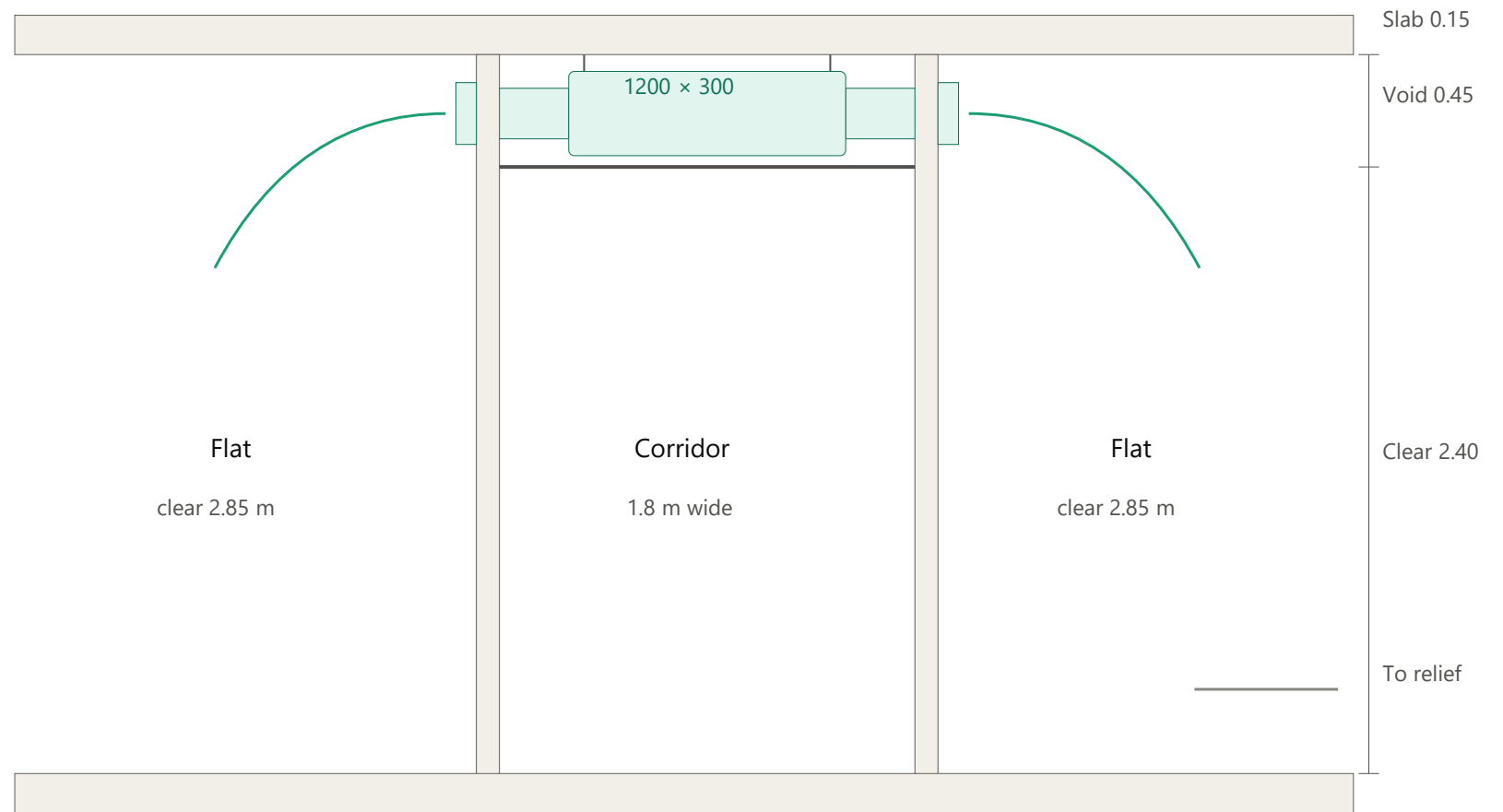


In affordable housing, relatively comfortable height to add some ducting if necessary

- Indian affordable housing (PMAY, EWS/LIG, and most private "affordable" segment projects), the typical floor-to-floor height is about 3.0 m.
- That number comes mainly from the National Building Code of India (NBC 2016, Part 3). Minimum clear height of 2.75 m for habitable rooms, measured from finished floor to the underside of the slab or ceiling.



Example of ducting up to each flat



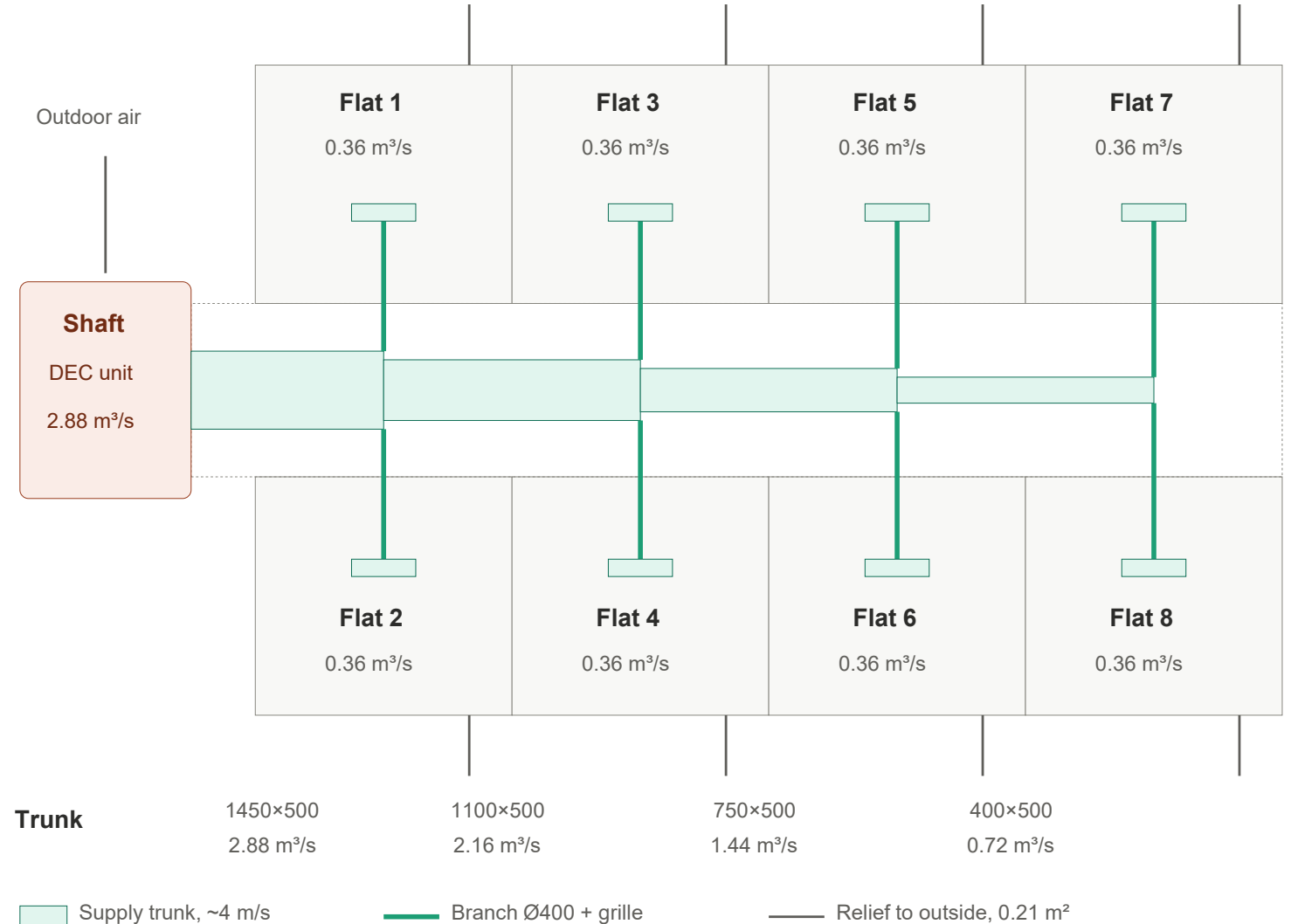
Section at trunk start · storey 3.00 m · corridor false ceiling at 2.40 m

Branch 600 × 200 through wall to side-wall grille ~800 × 300 (≈0.17 m² free)



Distribution from shaft to each flat

fsda



Testing, certification lacking for domestic systems in India (better for industrial applications)

- Recent certification from BIS (Bureau of Indian Standards (2025))
 - Certification is very recent and hard to enforce. The mandatory BIS requirement only applied from April 2025. A large part of the market is also unorganised: metal desert coolers are fabricated in local workshops and sold through small shops, and they rarely pass through any certification. Market surveillance on that scale is weak.
 - The BEE label appears to be voluntary. Manufacturers whose products would rate poorly simply don't register, so there's no star rating to display.
 - Nothing requires ads to state efficiency or delivered capacity. Sellers compete on price and on features buyers recognise: tank size in litres, "air throw" in metres, honeycomb pads, ice chambers, remote control, inverter compatibility.
 - Real effectiveness figure would expose differences between products. Without regulation forcing disclosure, nobody in a price-driven market wants to publish it first.
 - In short, the market rewards cheap, visible features, and the standard doesn't make real performance visible.
 - The 65% minimum versus field reality. If units pass 65% in the lab while field effectiveness is 35–55%



Testing, certification lacking for domestic systems in Europe

- Recent Eurovent Evaporative cooling does not consider systems below 2500 m³/hr and also portable units

a. Direct Evaporative Cooling (DEC)

The following units are specifically excluded from the scope:

- Units with an air flow less than 2,500 m³/h
- Units with an air flow greater than 120,000 m³/h
- Portable air-cooling units

b. Indirect Evaporative Cooling (IEC)

The scope includes:

- Indirect Evaporative Cooling units with primary outside air
- Indirect Evaporative Cooling units with separation of the outside and room air

Indirect Evaporative Cooling units with direct evaporative cooling stage are accepted under the scope. Indirect Evaporative Cooling units with DX coil (integrated in the unit) or chilled water coil (integrated in the unit) are accepted under the scope.

The following units are specifically excluded from the scope:

- Units with an air flow less than 2,500 m³/h
- Units with an air flow greater than 120,000 m³/h



TECHNICAL CERTIFICATION RULES OF THE EUROVENT
CERTIFIED PERFORMANCE MARK



EVAPORATIVE COOLING

Identification: ECP-24 EC

Revision 2021
(This version cancels and replaces any previous versions)

Approbation date: 06/07/2021

Comes into effect from: 01/08/2021

Importance of fast adaptation measures in Europe also ...`?

- Time scale of building improvement → decades
- Evaporative cooling → fast

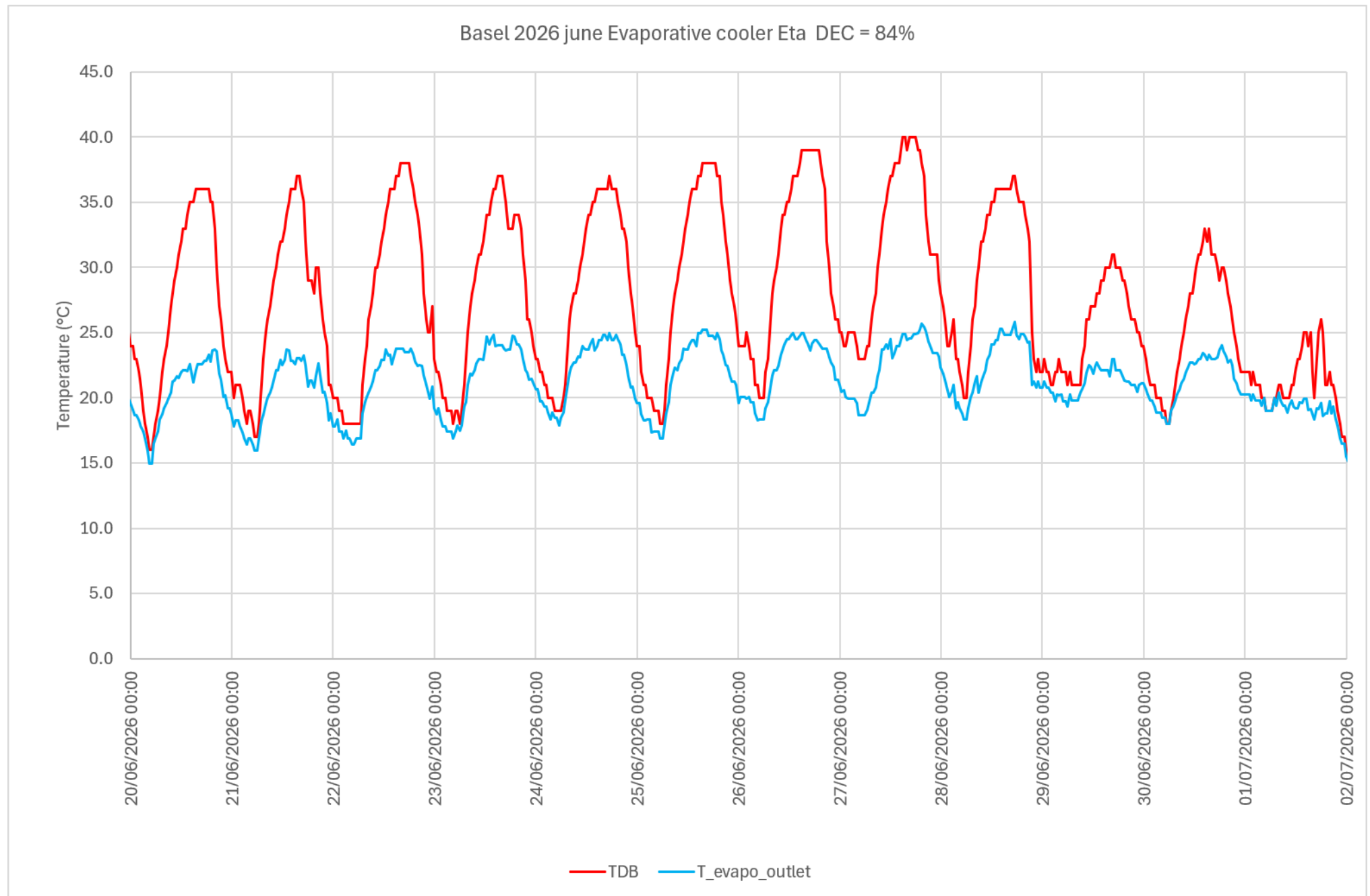


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Basel

Température
sèche (TDB) et
sortie après
évaporateur
(T_evapo_outlet)

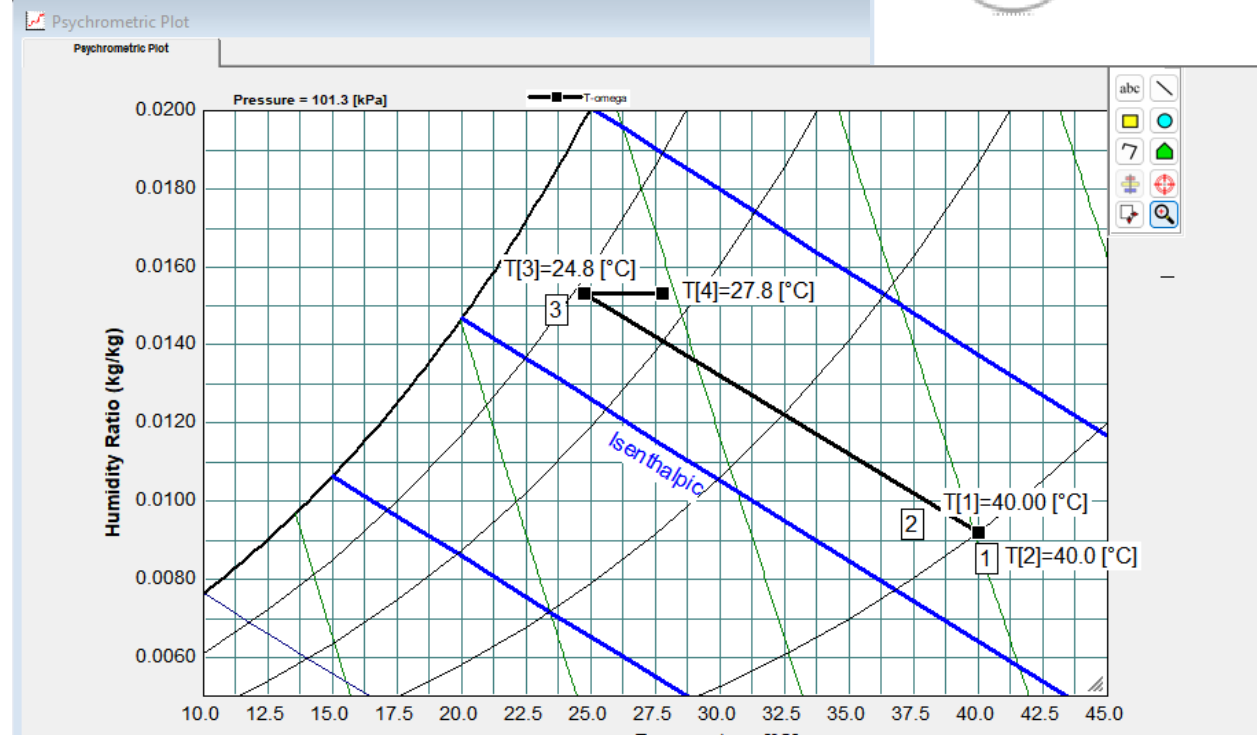
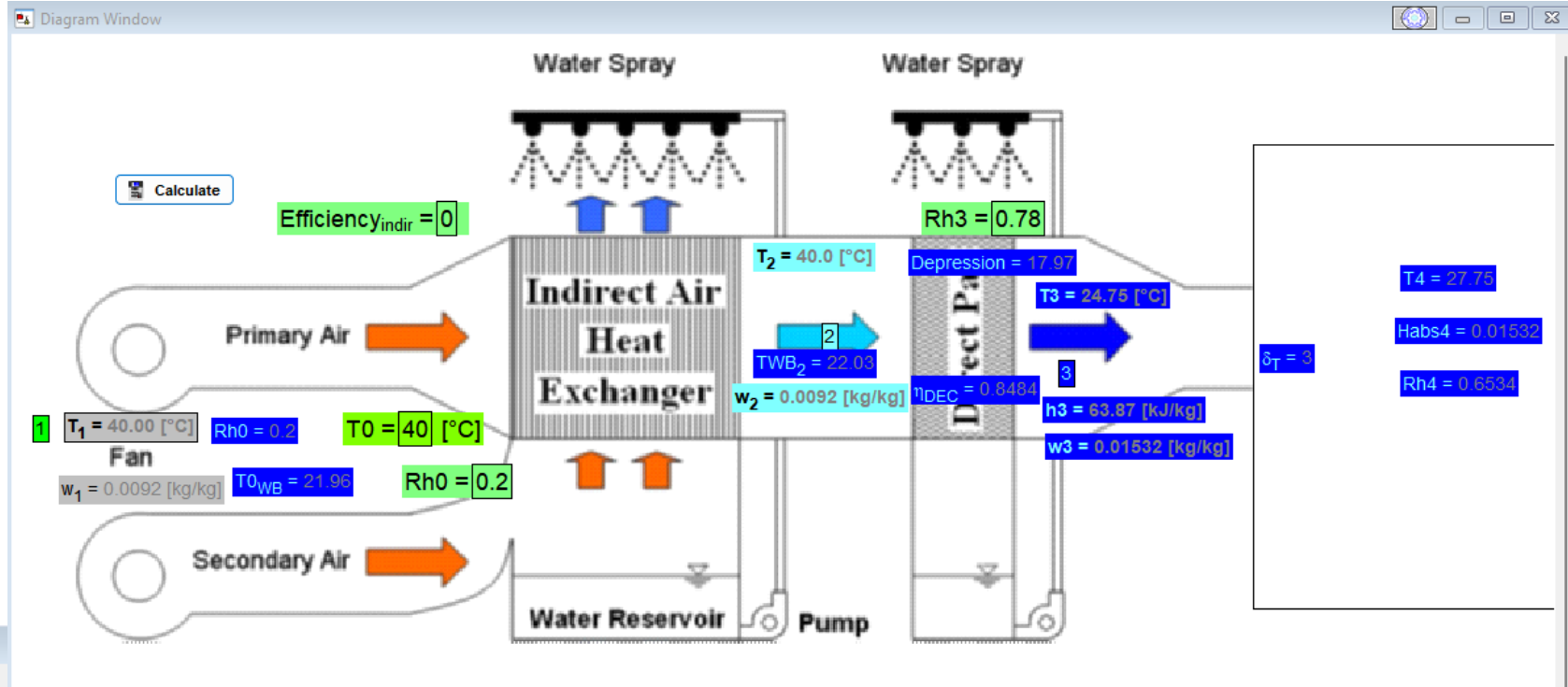
Jour le plus
chaud 40 (°C)





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Basel evaporation directe



Lack of performance testing in Europe for mobile evaporative cooler

- Search for tested mobile evaporative cooler
- → Found in Australia a model with certified performances as per Australian AS2913
- Not available internationally, so order in Australia and then import by a transport agency

Technical Information			
Air Flow	1,010 m ³ /hr	Water Capacity	14 Litres
Cooling Capacity*	1.2 kW	Dimensions (mm)	Shipping: 765 (H) x 565 (W) x 370 (D) Operating: 1020 (H) x 540 (W) x 430 (D)
Power	86 Watts	Weight	Shipping: 13 kg Net: 12 kg

Notes:

* Based on 38°C inlet, 27.4°C room (AS2913).

** Standard Dry Airflow.

*** Leaving Air DB (dry bulb) Temperature.

– All results were corrected to Standard Air (1.2kg/m³) where applicable.

– All units were tested at 230V and 50Hz.

– Negative cooling capacity results indicate the supply air temperature did not reduce below 27.4°C and no discernible cooling effect would be produced.

name comfort, using actual, deliverable kilowatts or cooling capacity.

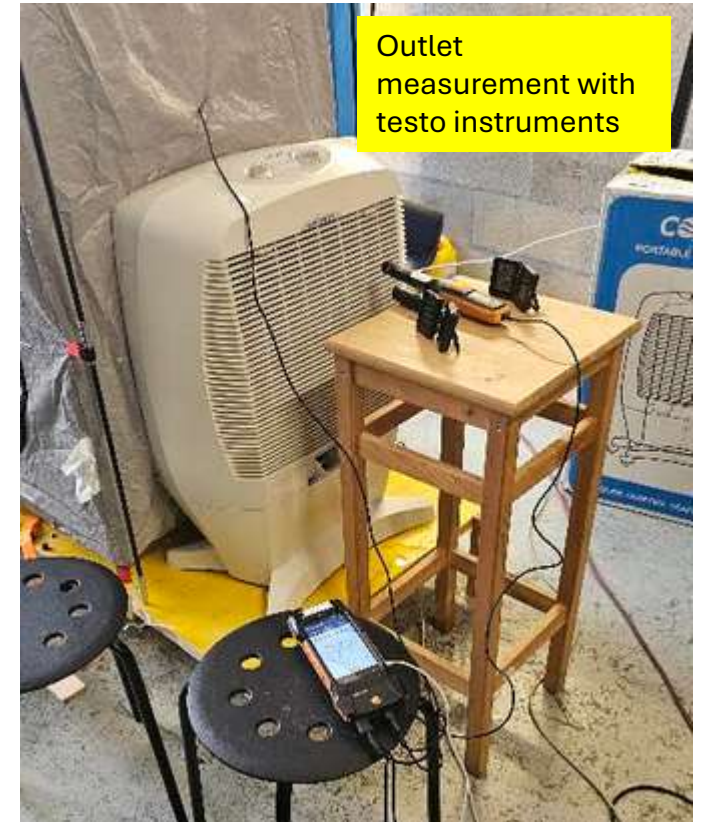
Product	Cooling Capacity (kW)*	Airflow (l/s)**	Supply Air Temp (°C)***	Power (W)	Evaporation Efficiency (%)
Convair Mastercool	1.2	245	23.6	86	85.0





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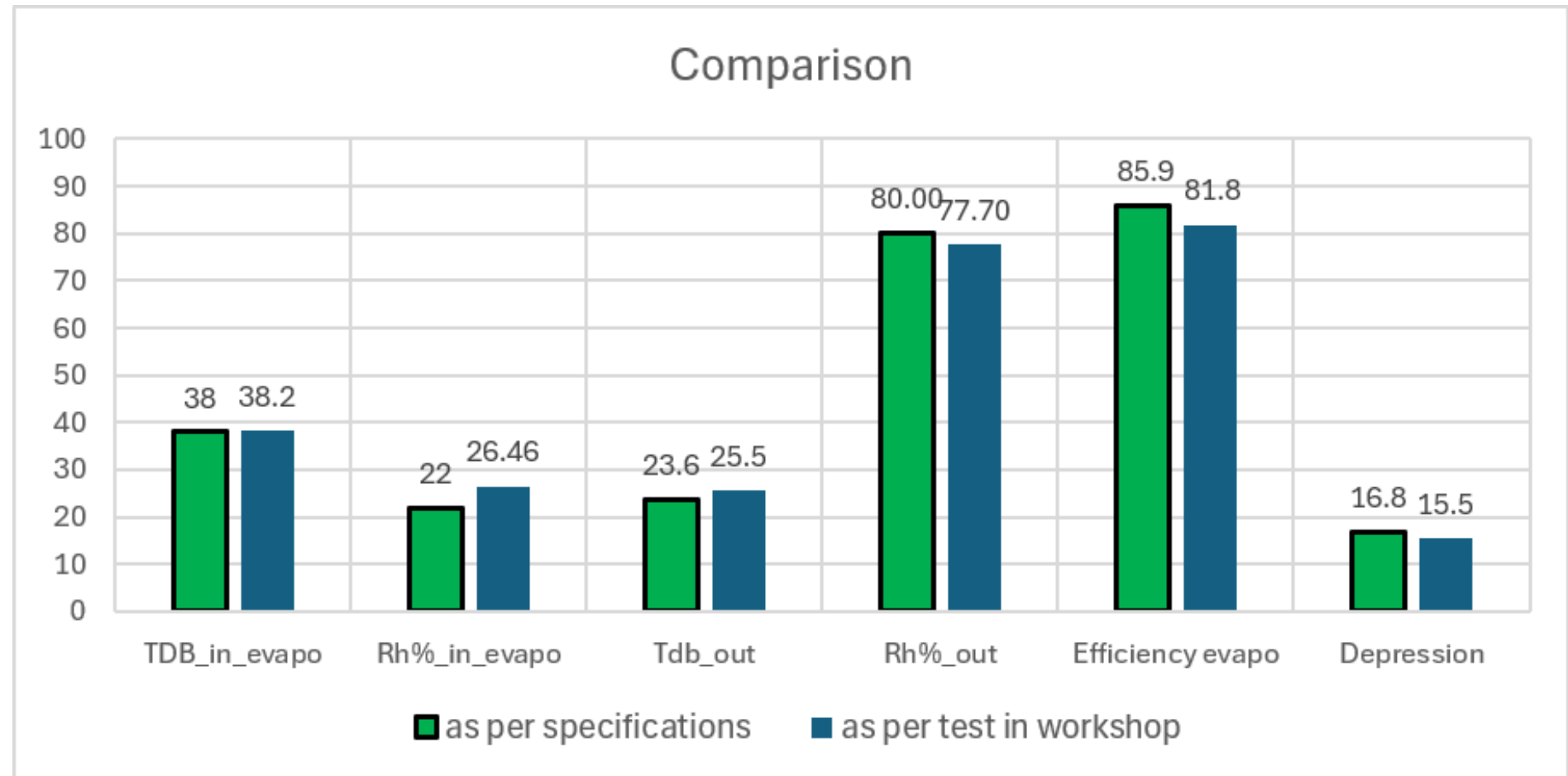
Quick test of the performance in a workshop





Mastercool quick testing in a workshop

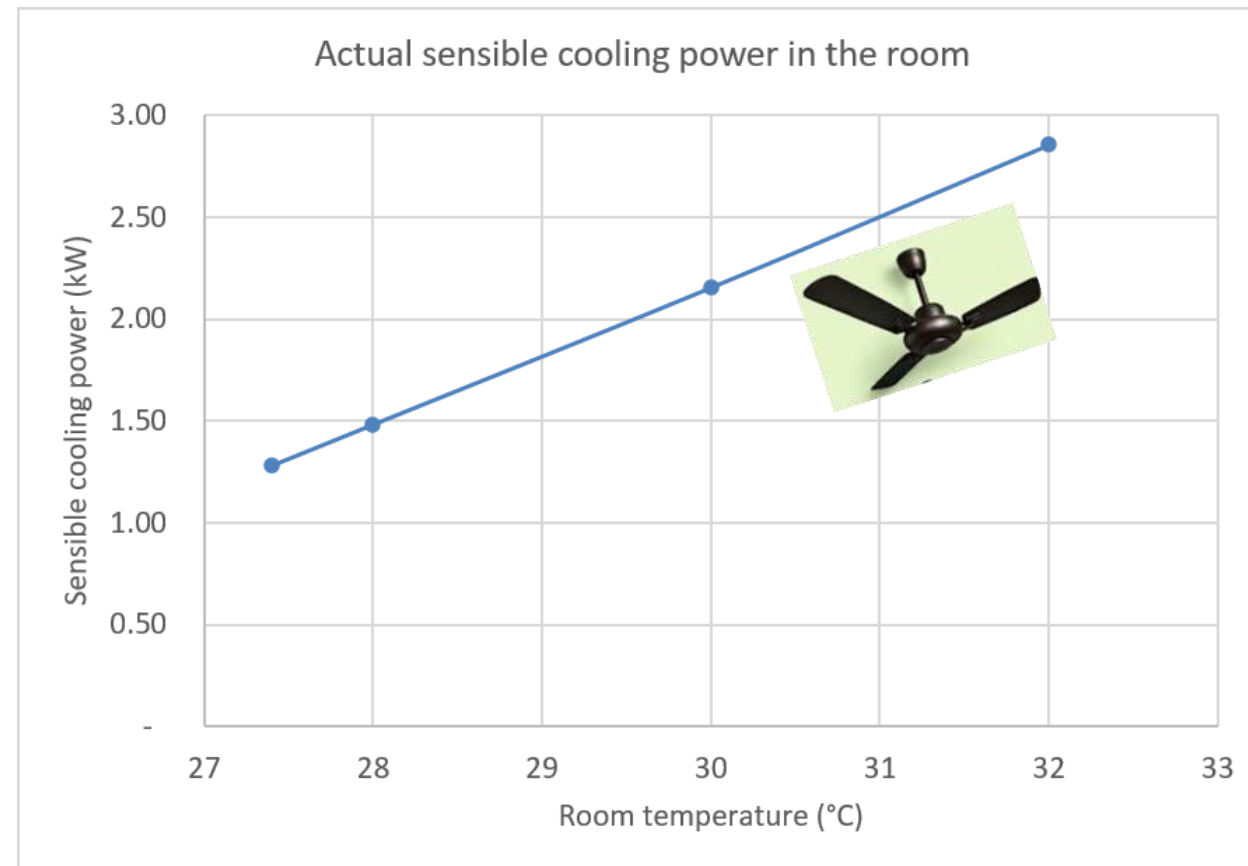
- Performances looks quite consistent,
- Needs more scientific testing and comparison for swiss climate





Actual sensible cooling as function of the room temperature

- The higher the room temperature the higher the cooling power
- Inclusion of ceiling fan extends the thermal comfort zone



CMS En Chardon

(CMC - Vernier)

Atelier Maintenance BUS

BIO-COOLER

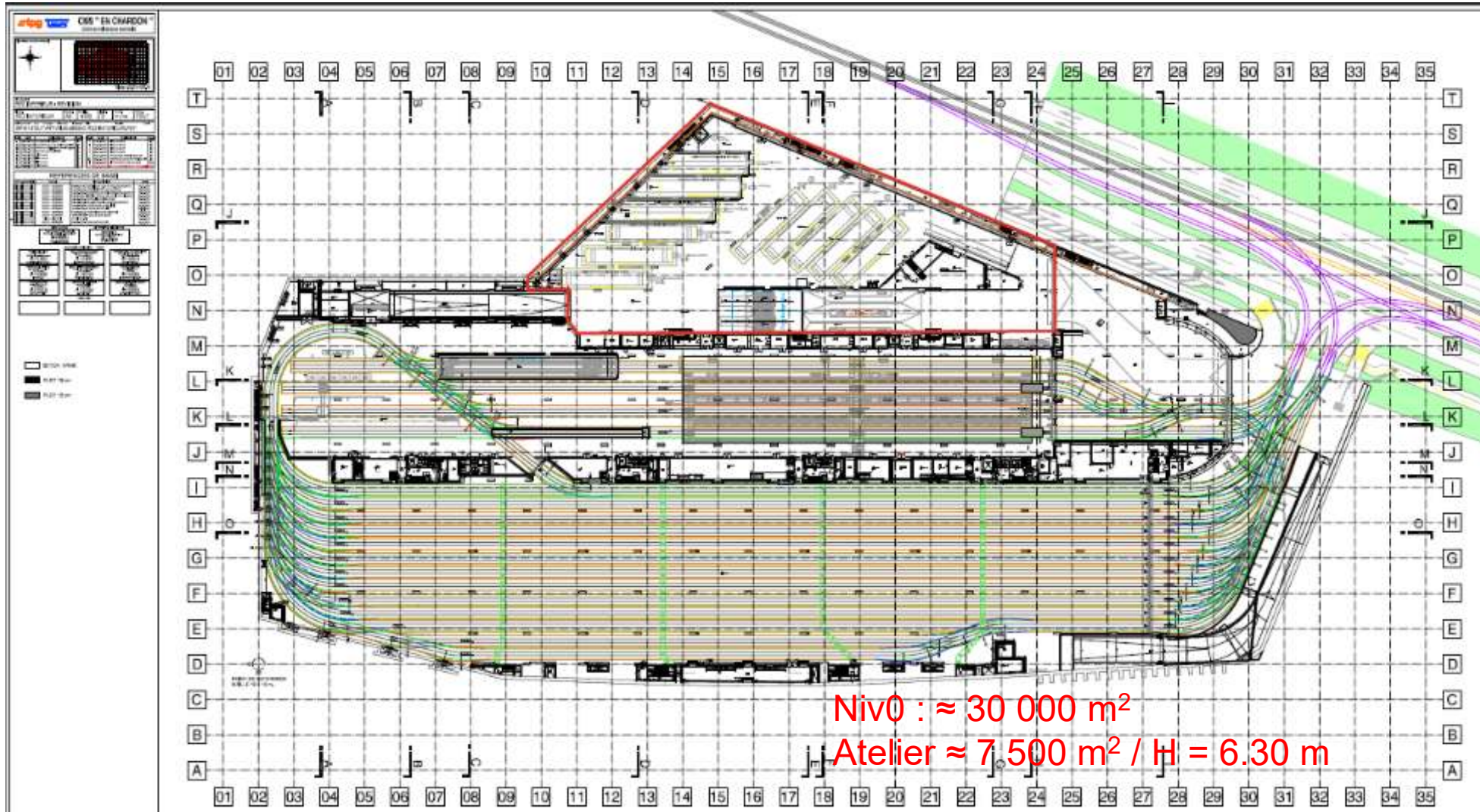
Refroidissement nocturne par
évaporation



σtpg

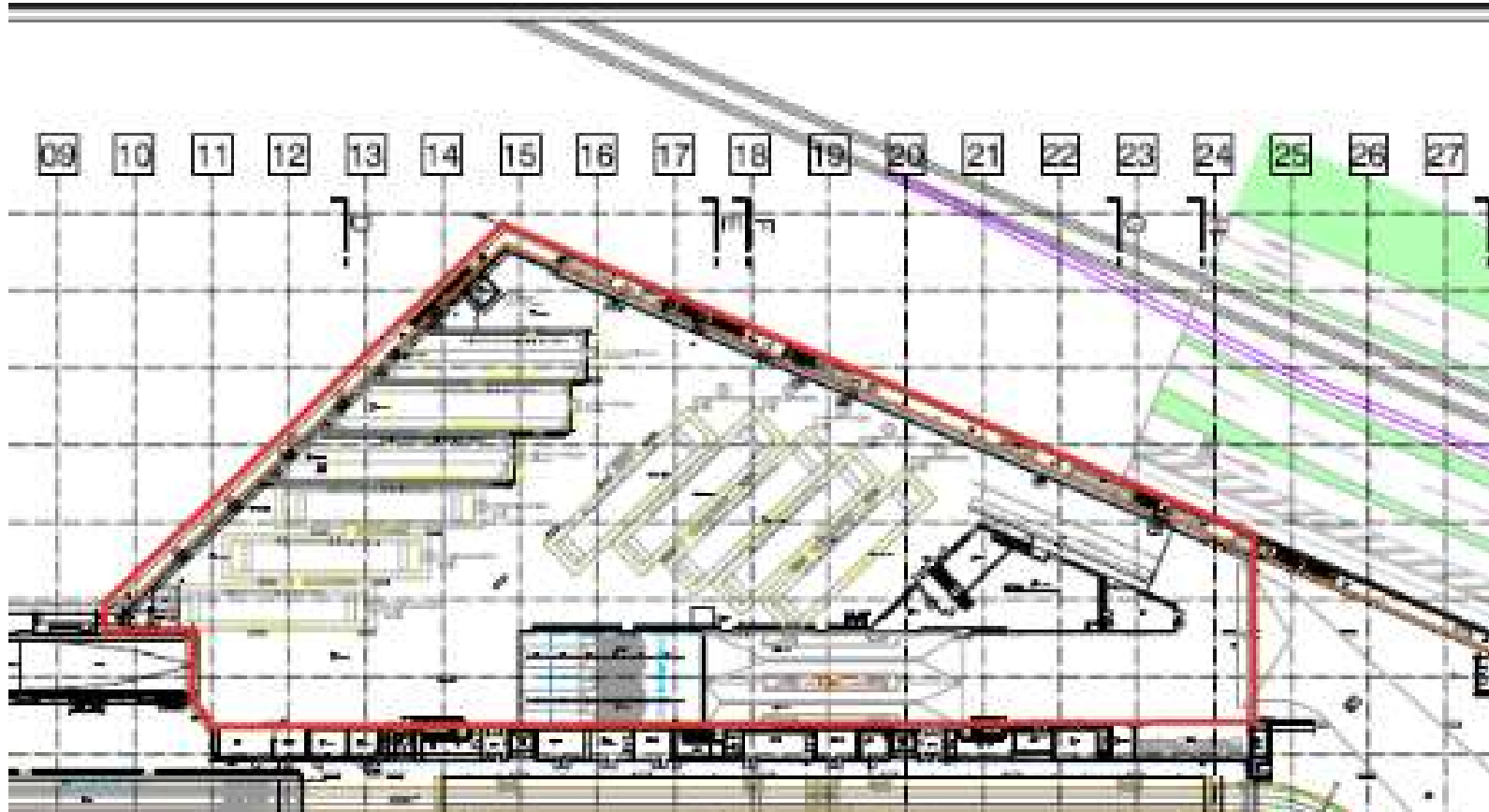
Refroidissement Nocturne

Atelier Maintenance Bus



Refroidissement Nocturne

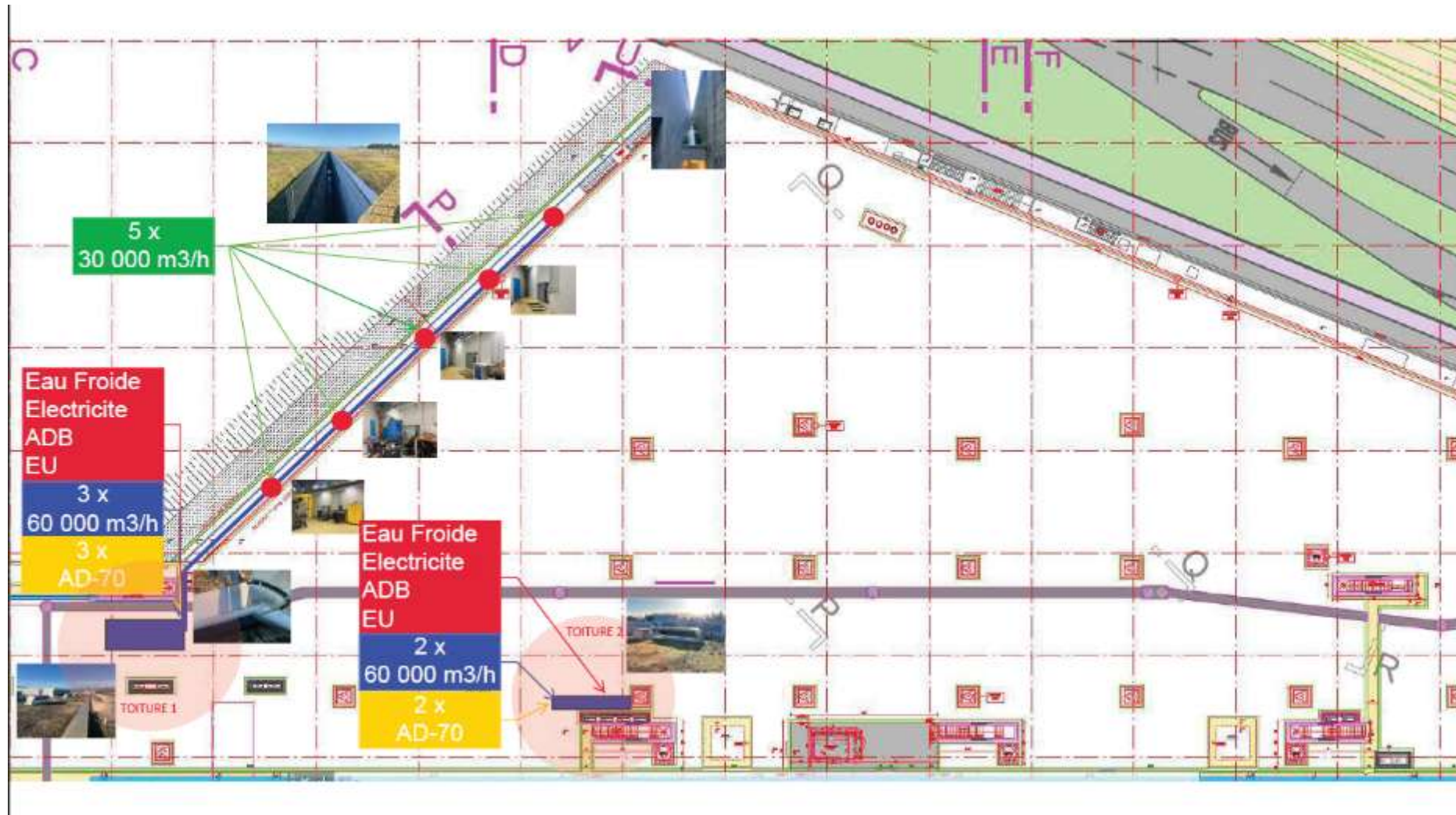
Atelier Maintenance Bus



Niv0 : $\approx 30\,000\text{ m}^2$

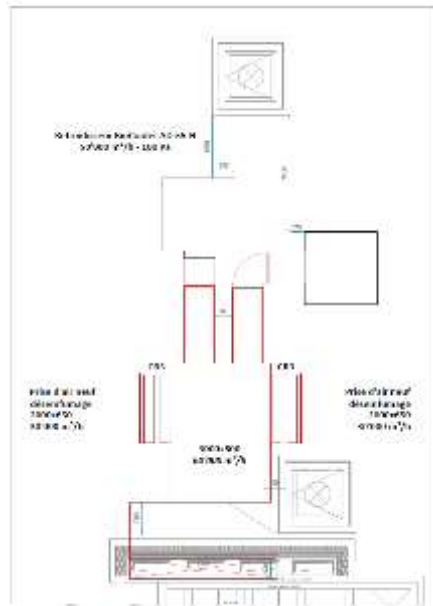
Atelier $\approx 7\,500\text{ m}^2$ / $H = 6.30\text{ m}$

Implantation BIO-COOLER

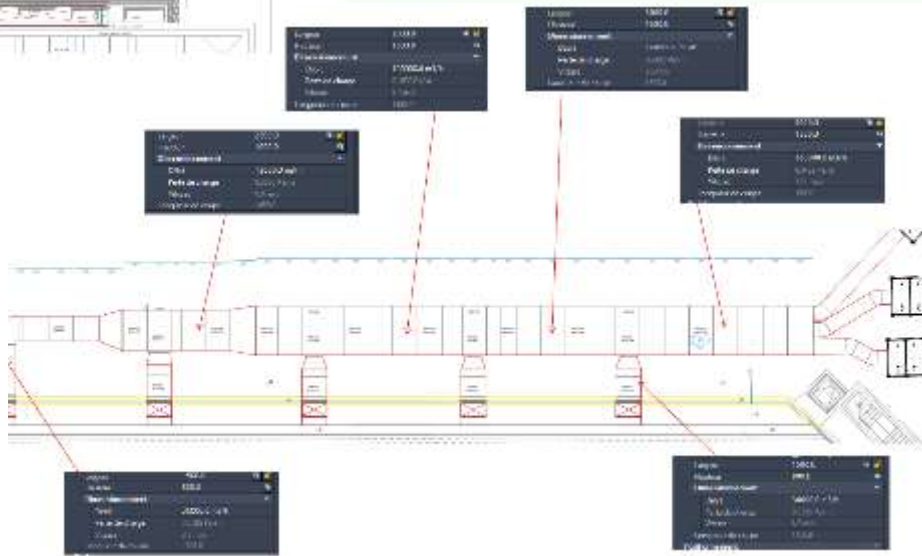
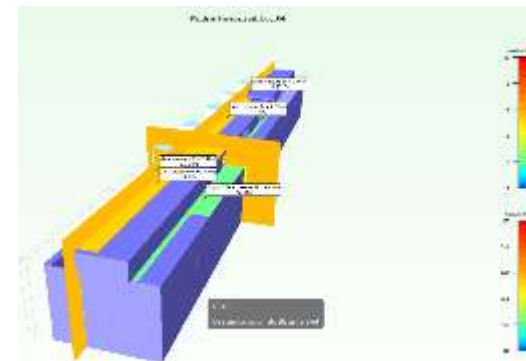
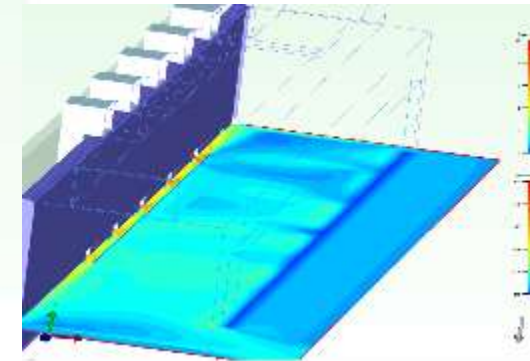
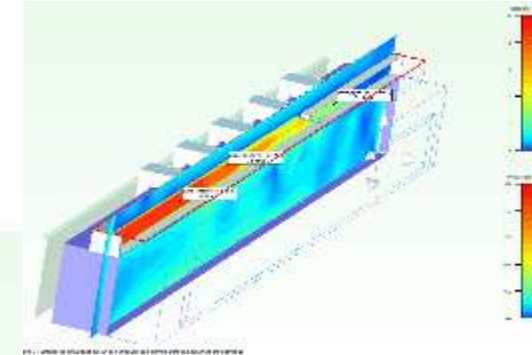
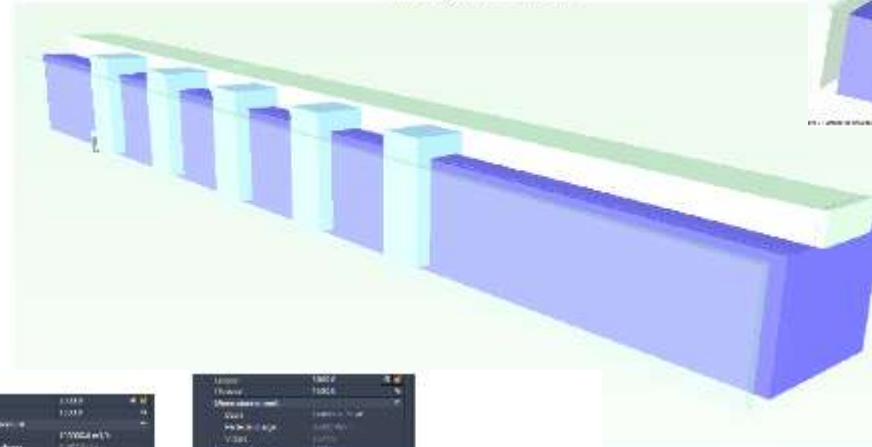


Etudes

De la Théorie à la Pratique



TPG En Chardon
Etude de soufflage et désenfumage dans le saut de lout
Lausanne le 26 février 2023
Pierre Joboyedoff et Mathias Blanc



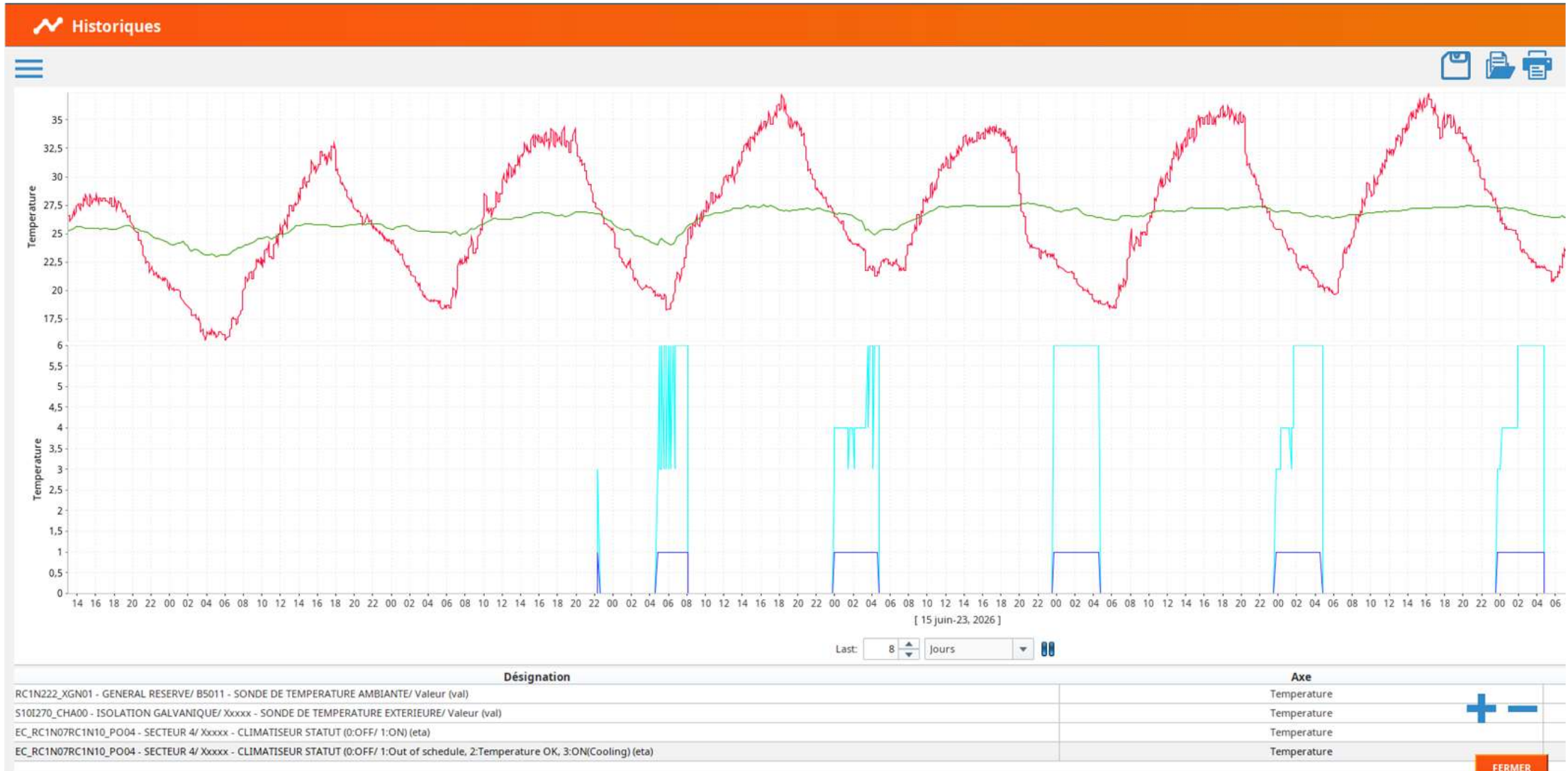
Aujourd'hui

Réalisation



Exemple de mesures en période chaude σtpg

Fonctionnement de 22h – 6 heures du matin au plus





□ Effin'Art
□ The Art of
□ Energy
Efficiency

- Thank you

