INNOclimat

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State of Qatar • دولة قطر

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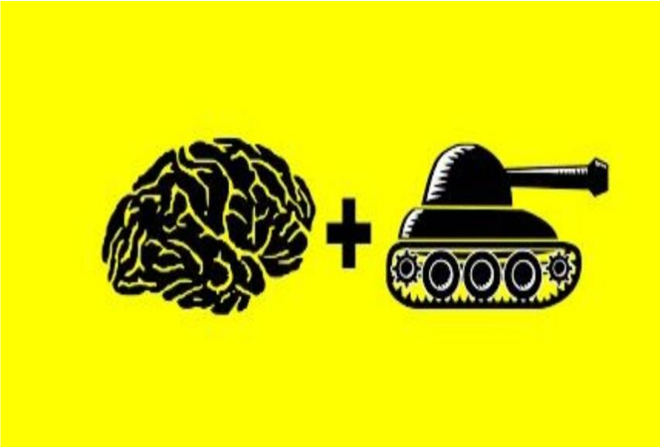

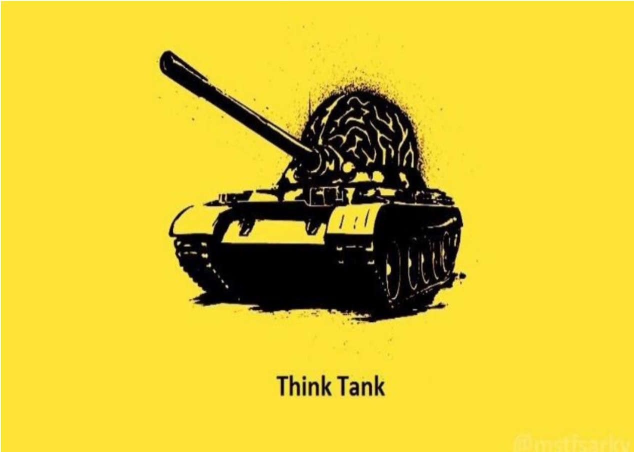

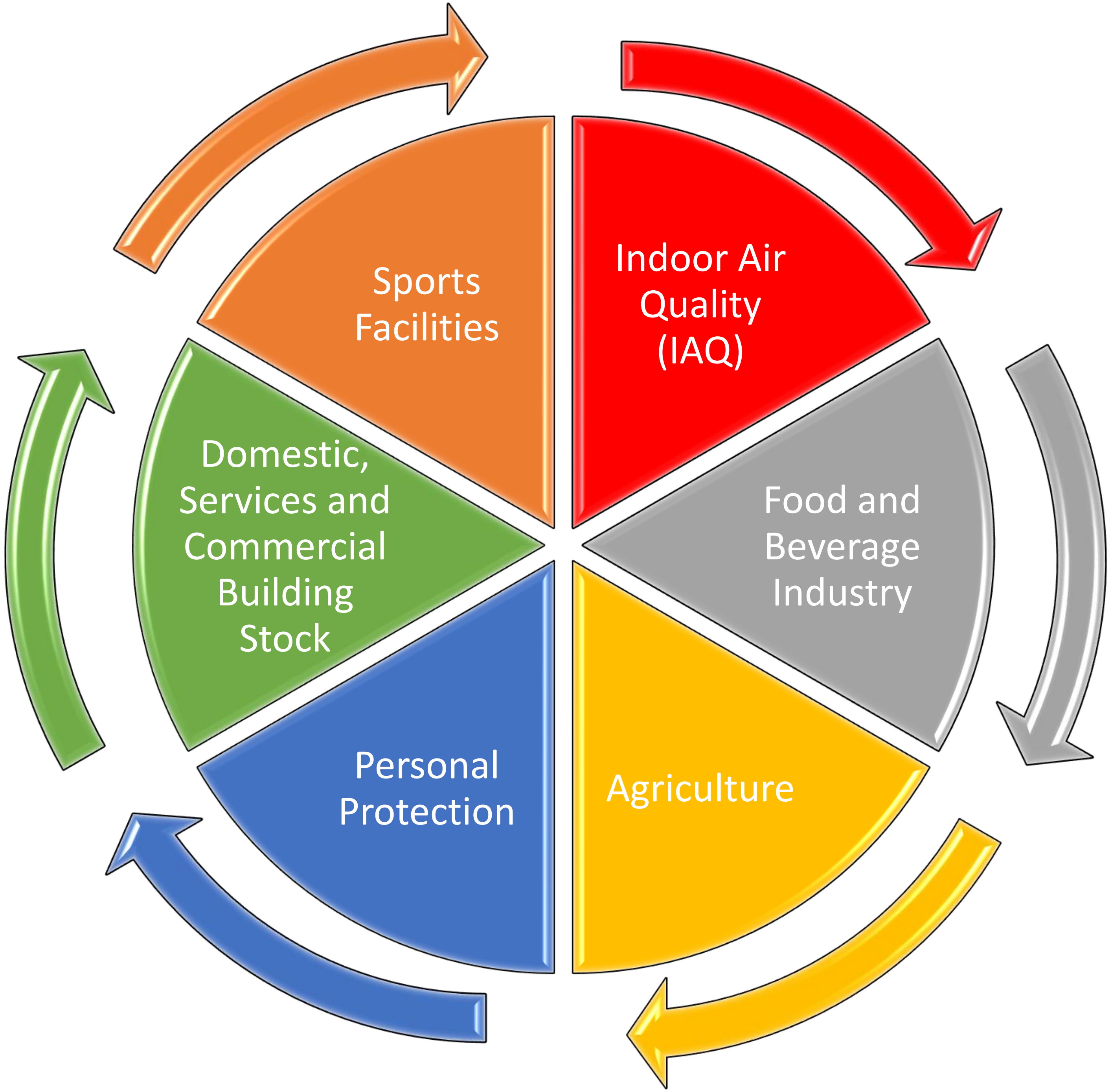

Sports Facilities
Indoor Air Quality (IAQ)
Food and Beverage Industry
Agriculture
Personal Protection
Domestic, Services and Commercial Building Stock

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Sports Facilities

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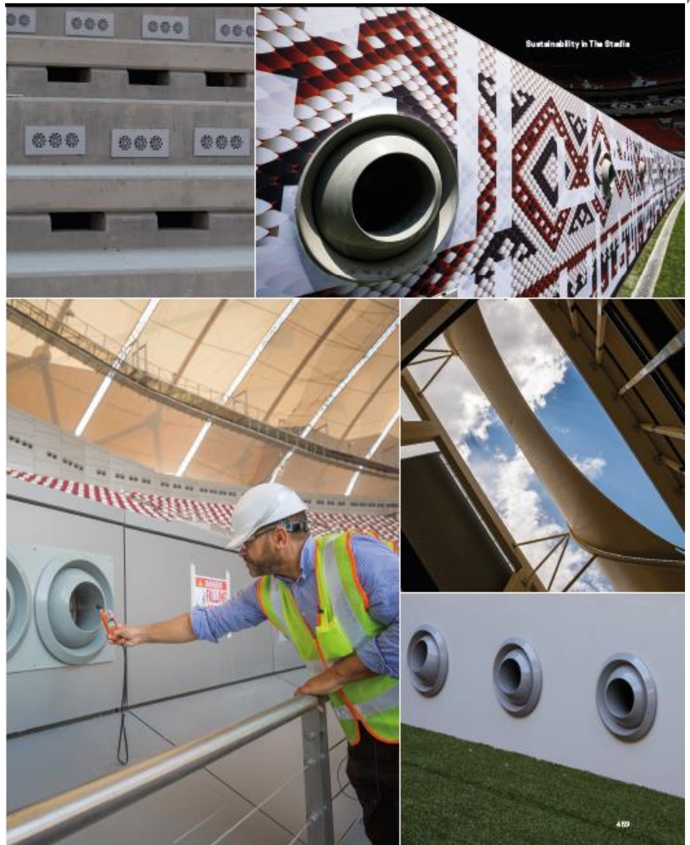
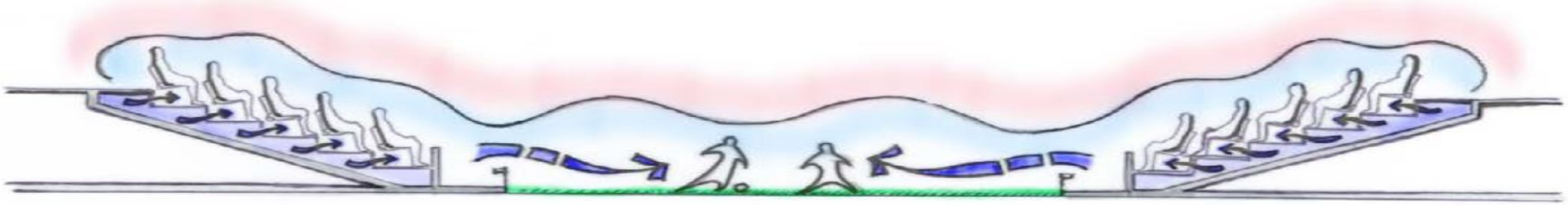
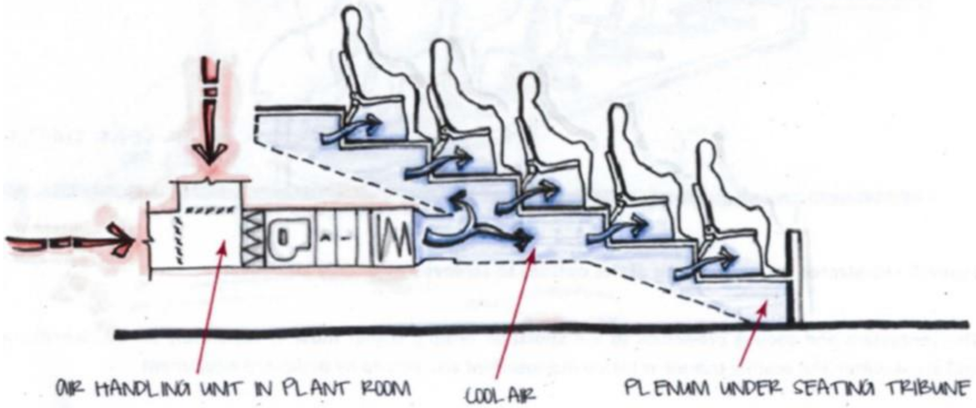






Obtaining SET and WBGT values from thermal camera data

Introduction

- Current metrics for thermal comfort include Standard Effective Temperature (**SET**) and Wet Bulb Globe Temperature (**WBGT**).

- WBGT is widely used in sports, especially football for determining thermal conditions at the stadium.

- Current sensors give only pointwise WBGT values.
- Other systems rely on tools found in the internet for evaluating WBGT/ SET.

Proposed system

- Current methods used are time consuming and require walking across the stadium while holding the sensor.

- The new proposed system provides a map of WBGT/SET values based on data from thermal camera and a weather station (instead of point values).

- The data is provided to the software via WiFi , and the program processes the data to obtain WBGT/ SET.

System description

- The system comprises of hardware and software parts.
- **The hardware:**
  - Thermal camera.
  - Sensors for temperature, humidity, wind speed (Weather station).
  - Globe temperature sensor.
  - WiFi Module.

- **The Software:**
  - The software receives sensors data and stores it.
  - The software processes the thermal image and obtains temperature values.
  - The GUI is used to display the results.

Benefits of the new system

- WBGT data can be obtained remotely without the need of being in the location where the reading is needed.
- The system provides a map of WBGT/SET in a much shorter time than the time required for obtaining such data using current systems.
- The system can be used in combinations with systems already installed in the stadiums.

Methodology

- SET is a function of: Air temperature, mean radiant temperature, relative humidity, wind speed, atmospheric pressure, clothing, metabolic rate.

$$\boxed{SET = f(T_{air}, T_{radiant}, RH, P_{atm}, V, Metabolic\ rate, Clothing)}$$

- WBGT can be found from the following equation

$$\boxed{WBGT = 0.1T_a + 0.7T_{nwb} + 0.2T_g}$$

- Where the inputs needed are the air temperature, natural wet bulb temperature and globe temperature.

Methodology

- The thermal camera provides temperature at surfaces.
- A correlation can be found between the surface temperature of a certain material (e.g. grass) and the air temperature.

- The other inputs are provided to the system by the sensors (Clothing and metabolic rate are entered by the user).

Thermal image analysis

Thermal camera

Thermal Image

Surface temperature values

768x1024 double

	1	2	3	4
1	32.1353	32.2129	32.2906	32.3682
2	32.1741	32.1741	32.2129	32.2518
3	32.2906	32.2518	32.2518	32.2129
4	32.4459	32.4071	32.3294	32.2518
5	32.4071	32.3682	32.2906	32.2129
6	32.2129	32.1741	32.1353	32.0965
7	32.0576	32.0576	32.0576	32.0965
8	32.0188	32.0576	32.1353	32.1741
9	32.0965	32.0965	32.0965	32.0965
10	32.2129	32.1741	32.1353	32.0965
11	32.1741	32.1353	32.0965	32.0576

Correlation (Surface to air temperature)

T_{air} (Celsius)

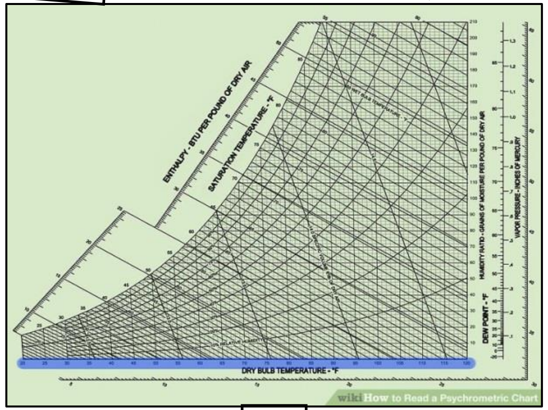
The thermal image map is read by the software. Using image processing, surface temperature is obtain and then the software performs a correlation to obtain air temperature values.

Wet bulb temperature

- The wet bulb temperature is obtained from the readings of both the temperature (from thermal camera) and the relative humidity sensor.

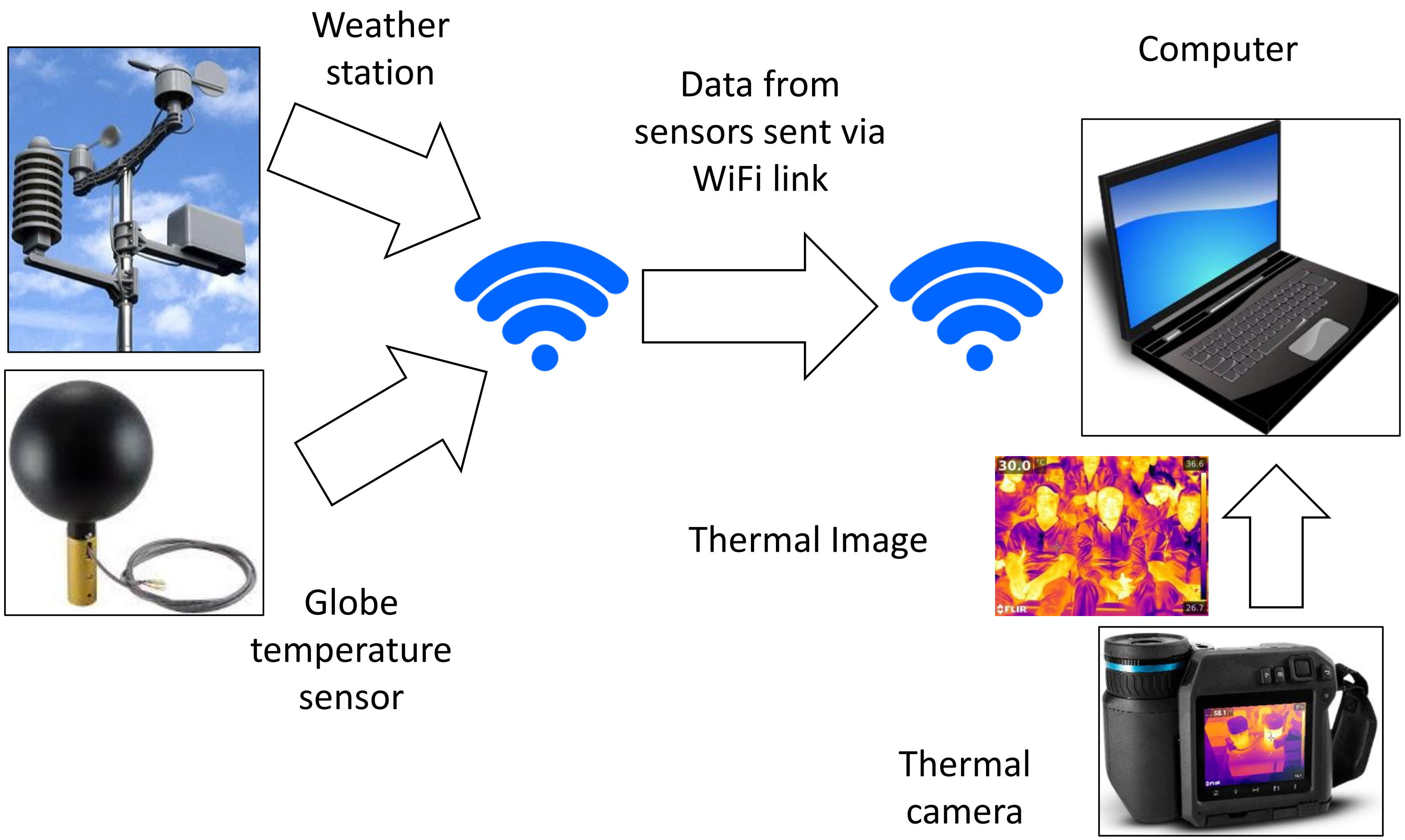
$T_{dry\ bulb}$
$(Celsius)$

$Relative\ humidity$
$(\%)$



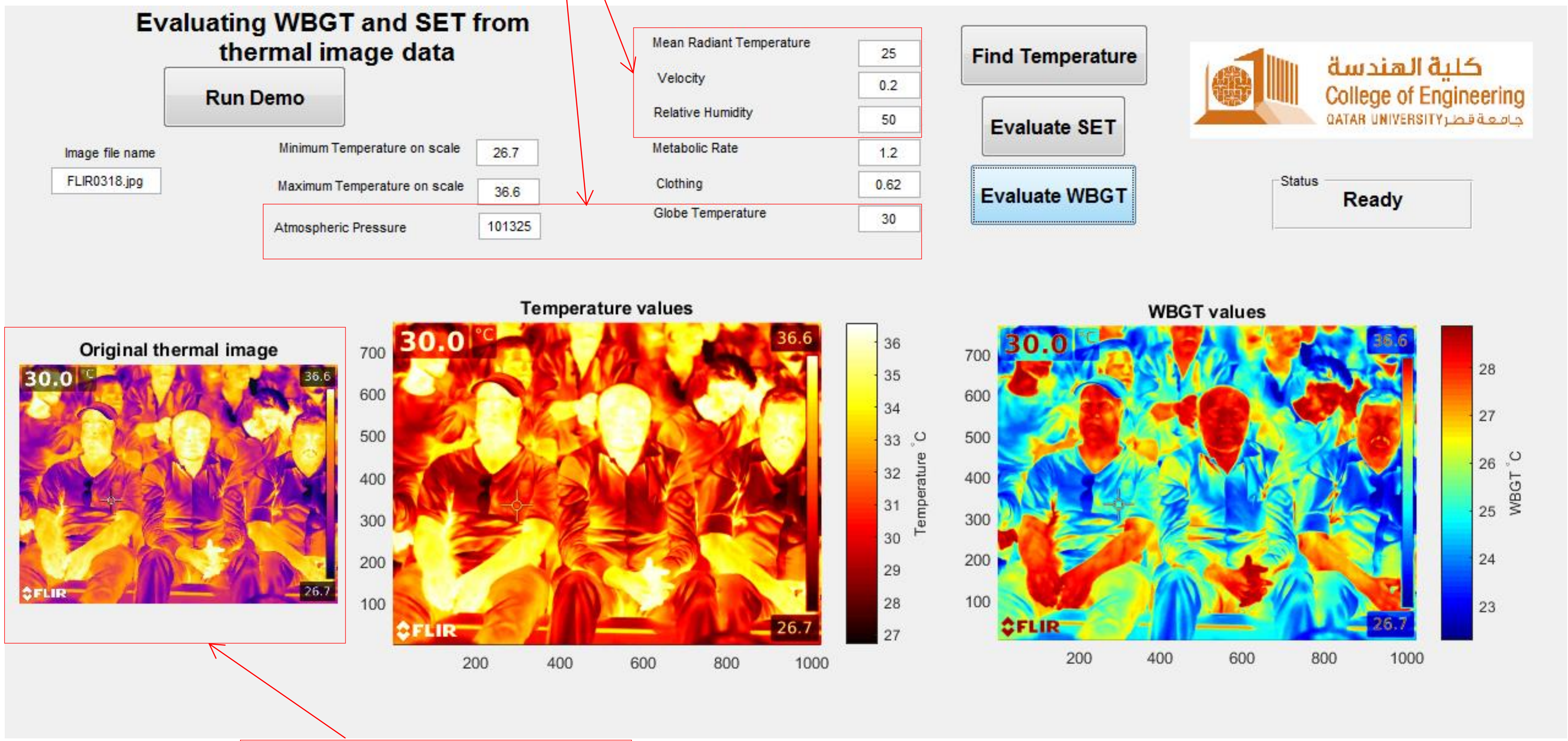
$T_{wet\ bulb}$
$(Celsius)$

System Architecture



Software GUI (example)

From sensors data



Original thermal image

Appendix: Code

```
function SET=SET_Calc_fcn(TA, TR, VEL, RH, MET, CLO, WME, PATM)
% Helper function for SET calculates Saturated Vapor Pressure (Torr) at
% Temperature T (°C)
% Input variables – TA (air temperature): °C, TR (mean radiant temperature): °C,
% VEL (air velocity): m/s,
% RH (relative humidity): %, MET: met unit, CLO: clo unit, WME (external work): W/m2 , PATM (atmospheric
% pressure): kPa

KCLO = 0.25;
BODYWEIGHT = 69.9; %kg
BODYSURFACEAREA = 1.8258; %m2
METFACTOR = 58.2; %W/m2
SBC = 0.000000056697; %Stefan-Boltzmann constant (W/m2 K4)
CSW = 170.0;
CDIL = 120.0;
CSTR = 0.5;
LTIME = 60.0;
VaporPressure = RH * FindSaturatedVaporPressureTorr(TA)/100.0;
AirVelocity = VEL;
TempSkinNeutral = 33.7;
TempCoreNeutral = 36.49;
TempBodyNeutral = 36.49;
```

Appendix: Code

```
function WBGT=WBGT_Calc(Ta,RH,Tg,P)
% MATLAB function to evaluate the WBGT


T_wb=Twb_calc(Ta,RH,P);


WBGT=0.7*T_wb+0.2*Tg+0.1*Ta;
```

```
function Twb=Twb_calc(T,RH,P)
%calc Twb from Tdb and w using ASHRAE 2013 fundamentals eq. 35
% w isobtained from RH
c_air = 1006; %J/kg, value from ASHRAE 2013 Fundamentals eq. 32
hlg = 2501000; %J/kg, value from ASHRAE 2013 Fundamentals eq. 32
cw  = 1860; %J/kg, value from ASHRAE 2013 Fundamentals eq. 32

% w calculation from RH

Pws=Saturation_pressure2(T);
Pw=(RH.*Pws)/100; %partial pressure of water wapor from RH
w=0.621945*Pw./(P-Pw);
```

Appendix: Code

```
function Pws = Saturation_pressure(Tdb)
%saturated water vapor pressure ASHRAE 2013 fundamentals eq. 6
T=Tdb+273.15;
Pws=exp(-(5.8002206e3)./T+1.3914993+-(4.8640239e-2)*T+(4.1764768e-5)*(T.^2)...
    -(1.4452093e-8)*(T.^3)+6.5459673.*log(T)); %in Pa valid for 0 to 200C
Pws=Pws/1000; % in kPa
end
```

```
function SVP=FindSaturatedVaporPressureTorr(T)
SVP=exp(18.6686 - 4030.183./(T + 235.0));
end
```


24.8 °C
36.3
17.2


Legacy in Action
Dr. Cool: The engineer behind
Qatar 2022's air-cooled stadiums


Indoor Air Quality (IAQ)
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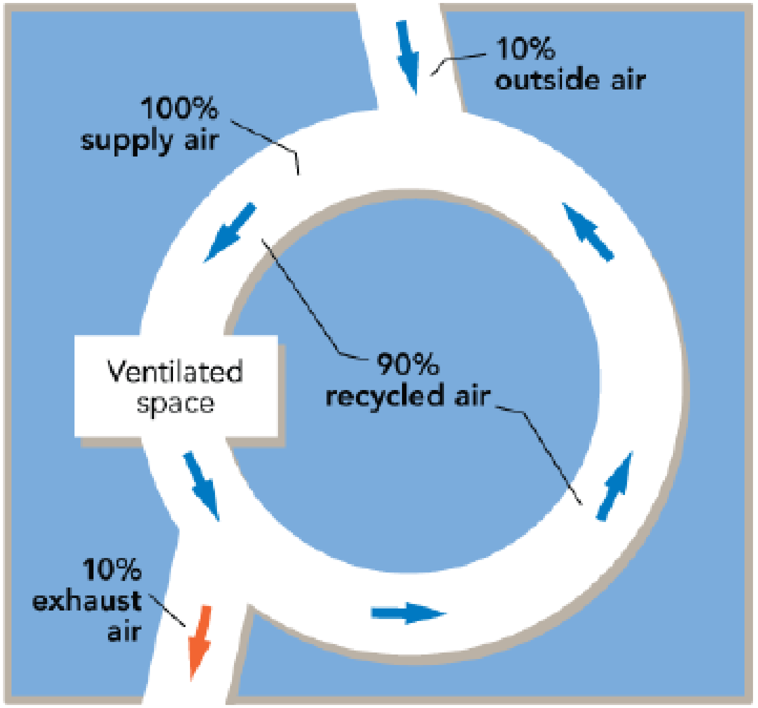
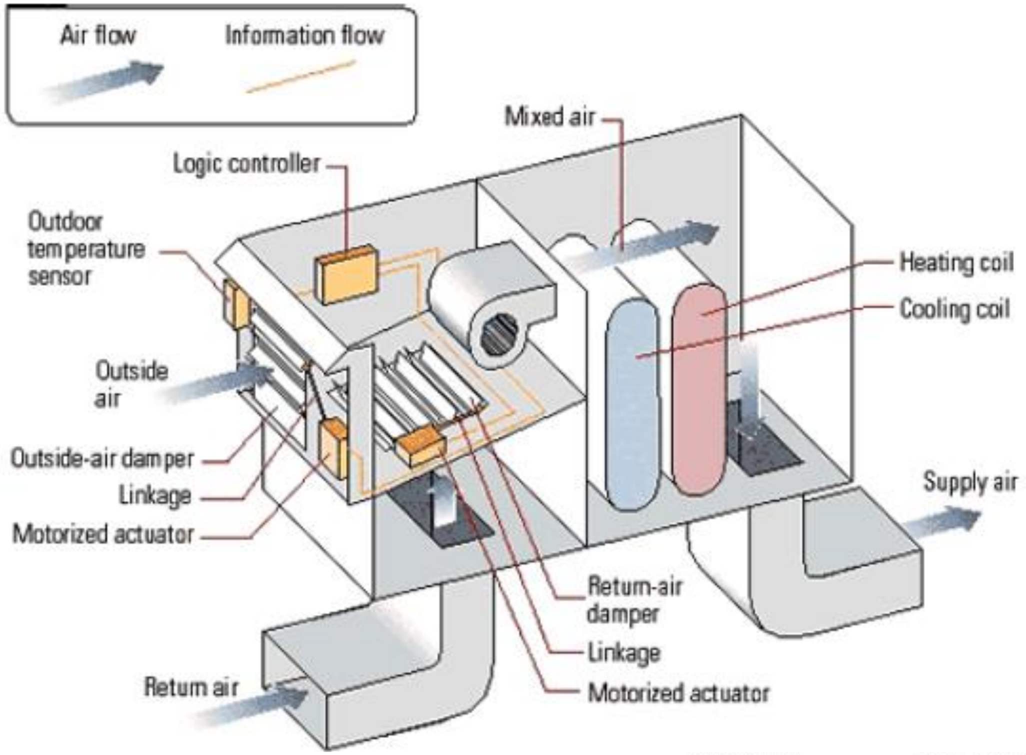
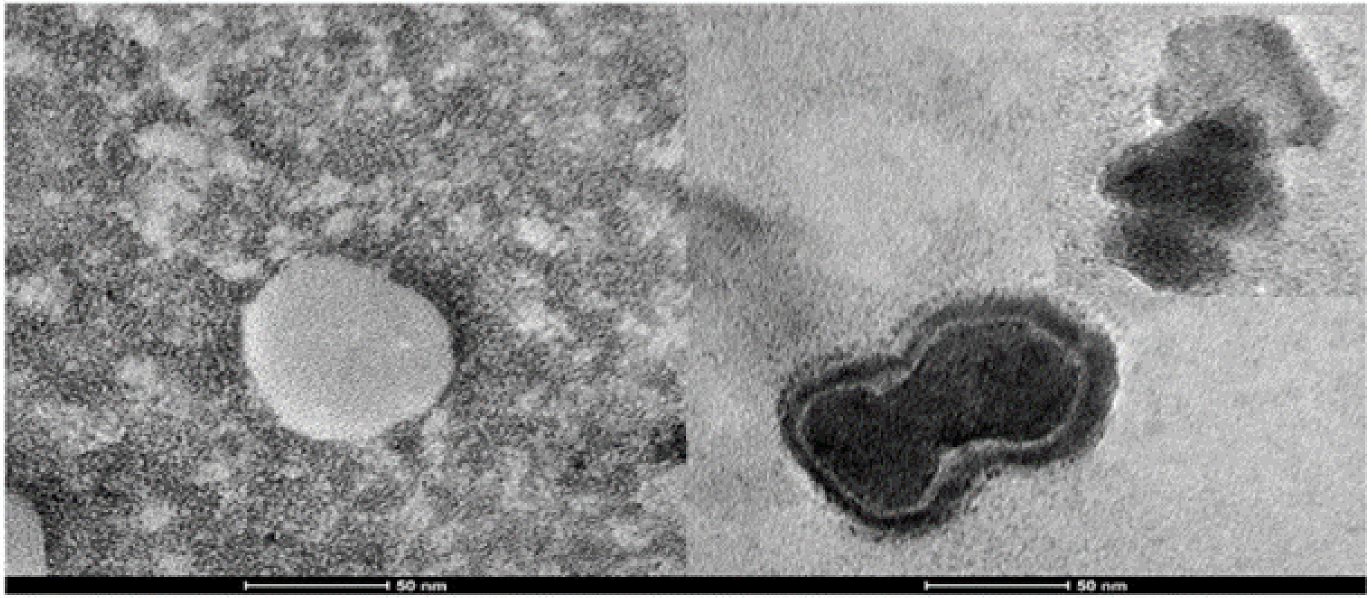
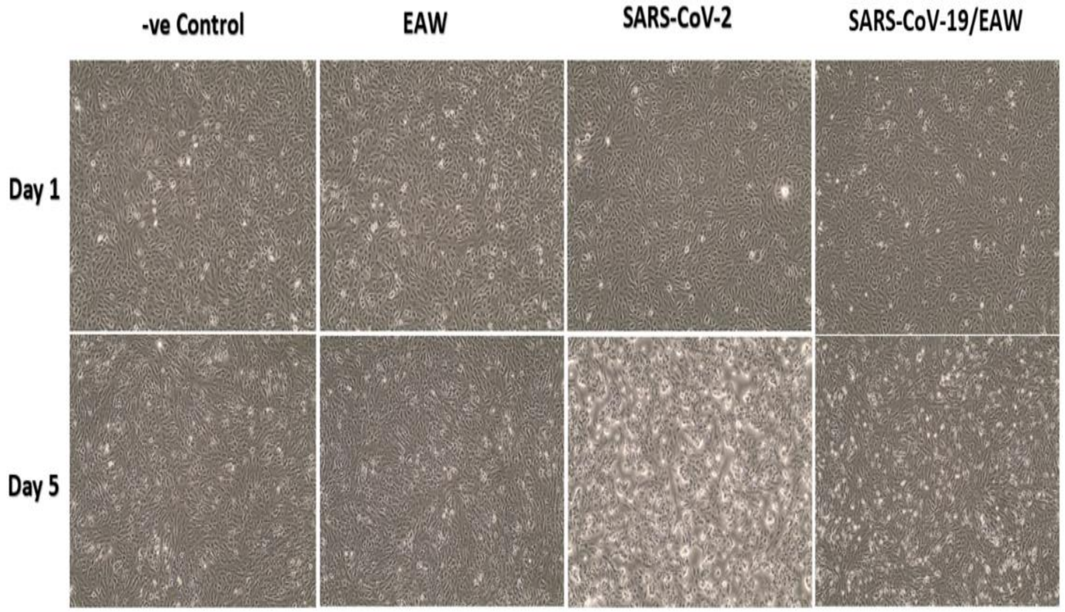
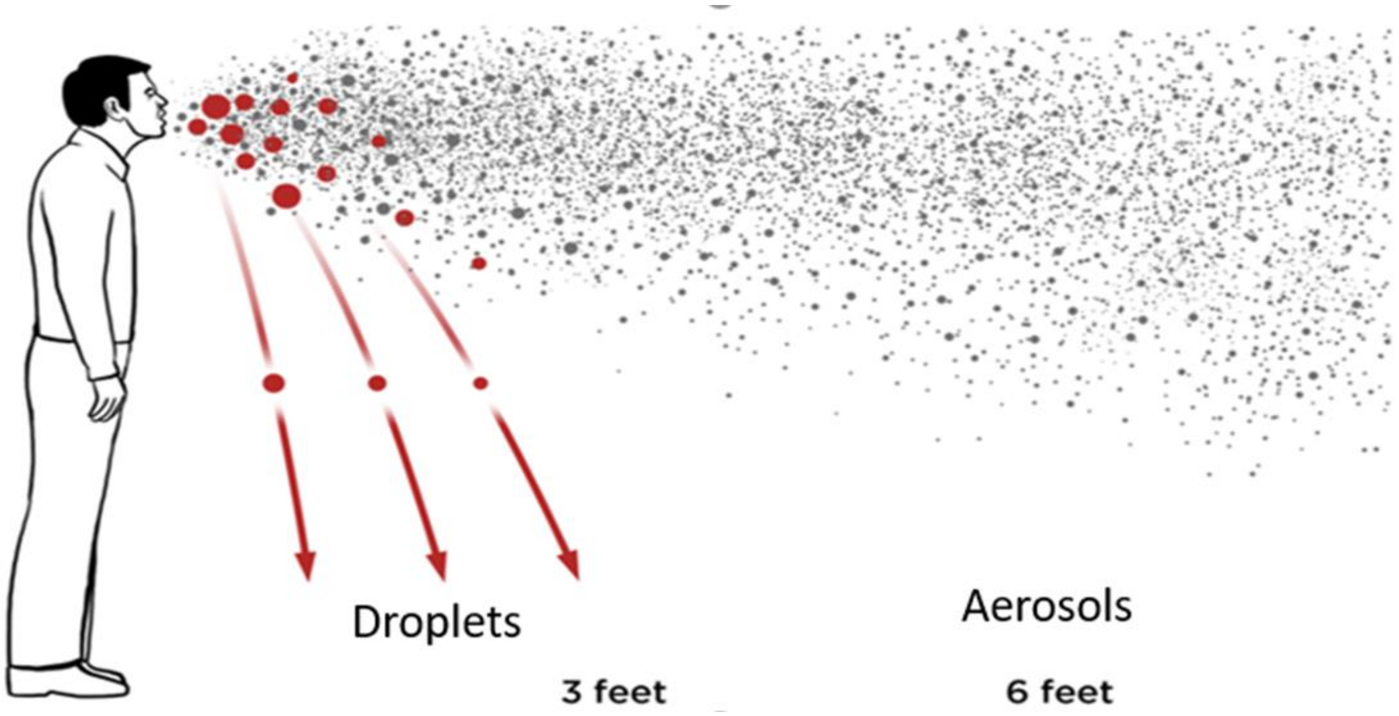

10%
outside air
100%
supply air
Ventilated
space
90%
recycled air
10%
exhaust
air


Air flow
Information flow
Mixed air
Logic controller
Outdoor
temperature
sensor
Heating coil
Cooling coil
Outside
air
Outside-air damper
Linkage
Motorized actuator
Supply air
Return-air
damper
Linkage
Motorized actuator
Return air


50 nm
50 nm


-ve Control
EAW
SARS-CoV-2
SARS-CoV-19/EAW
Day 1
Day 5

Airborne pathogens, why should we care?



- COVID-19
- Influenza
- Measles
- TB
- Whooping cough
- Aspergillosis

❖ **Droplet/aerosols and airborne transmission of infectious diseases are well documented in current research**

Airborne pathogens, why should we care?

- Airborne acquired infections can cause significant morbidity, mortality and associated with substantial management cost
- High-efficiency particulate air filters (HEPA) of different grades are the current industry standard
- There are very limited publications addressing the role of controlling the transmission of airborne diseases.
- There is an urgent need for innovating solutions with high efficiency and cost-effectively that address airborne transmission of infectious diseases including COVID-19

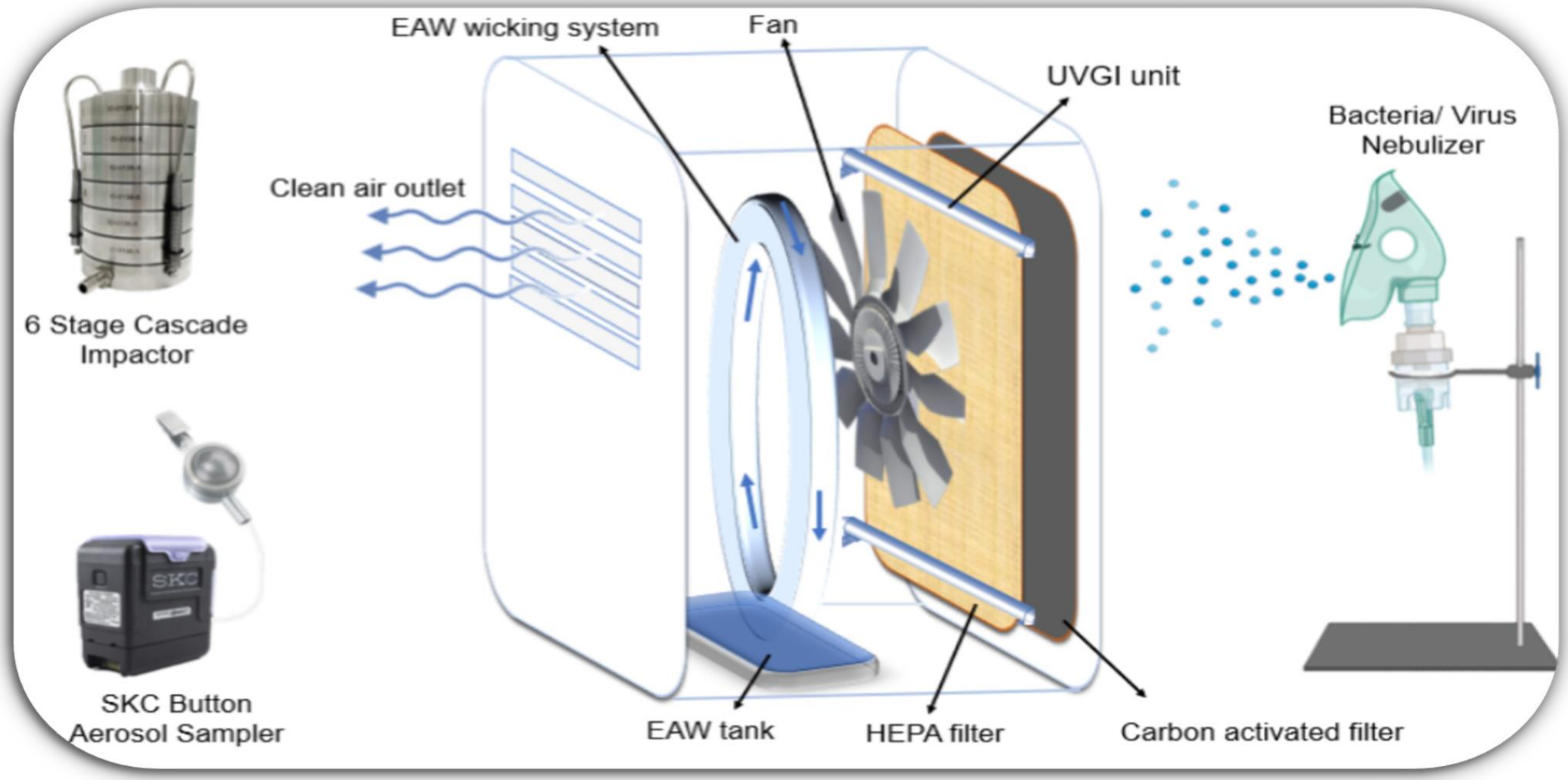
Objectives

- **Mitigation of airborne transmitted diseases in an indoor environment using a novel cleaning prototype device**

- **Assessing the efficacy of the novel porotype device**

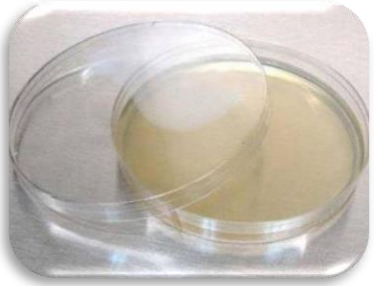
- **Comparing the efficacy of the porotype to the standard method**

Modified integrated cooler portable unit prototype during bacterial and virus testing

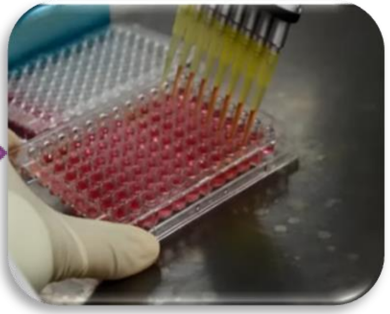


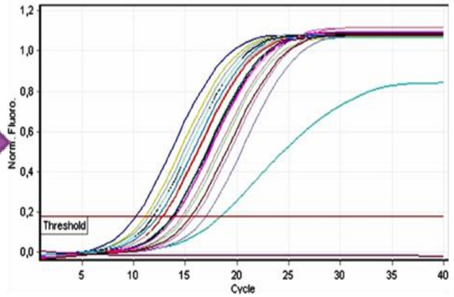
Methodology

Bacteria



Virus

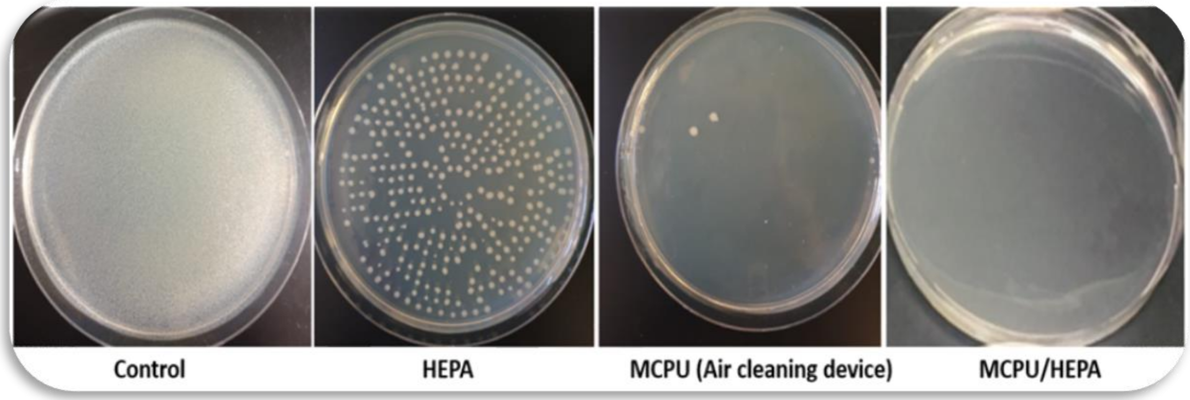


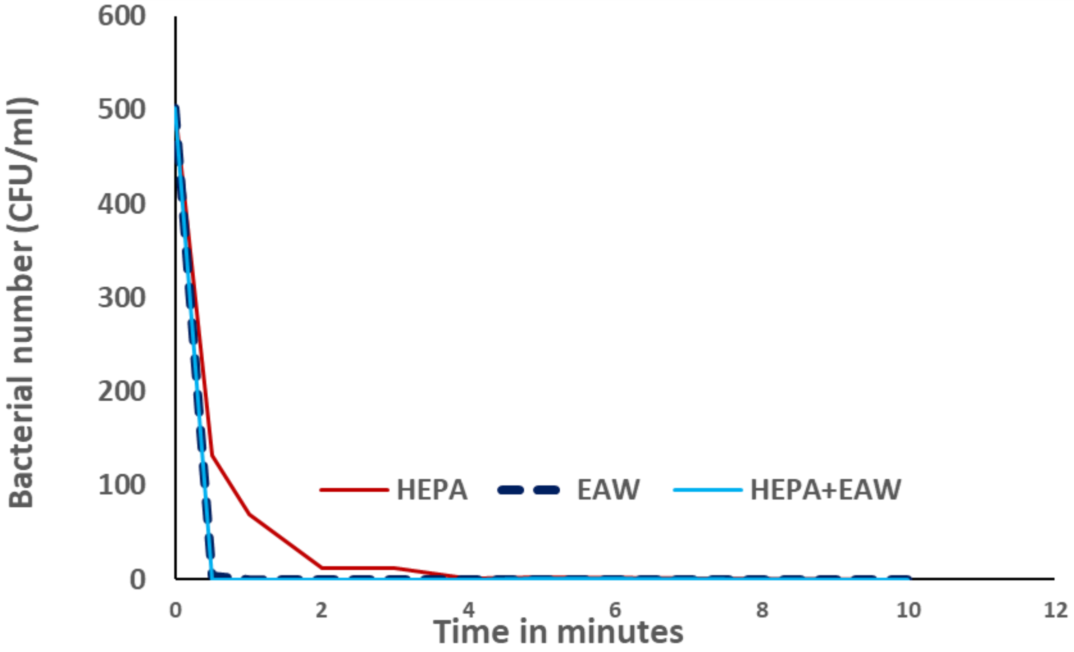


Fungus

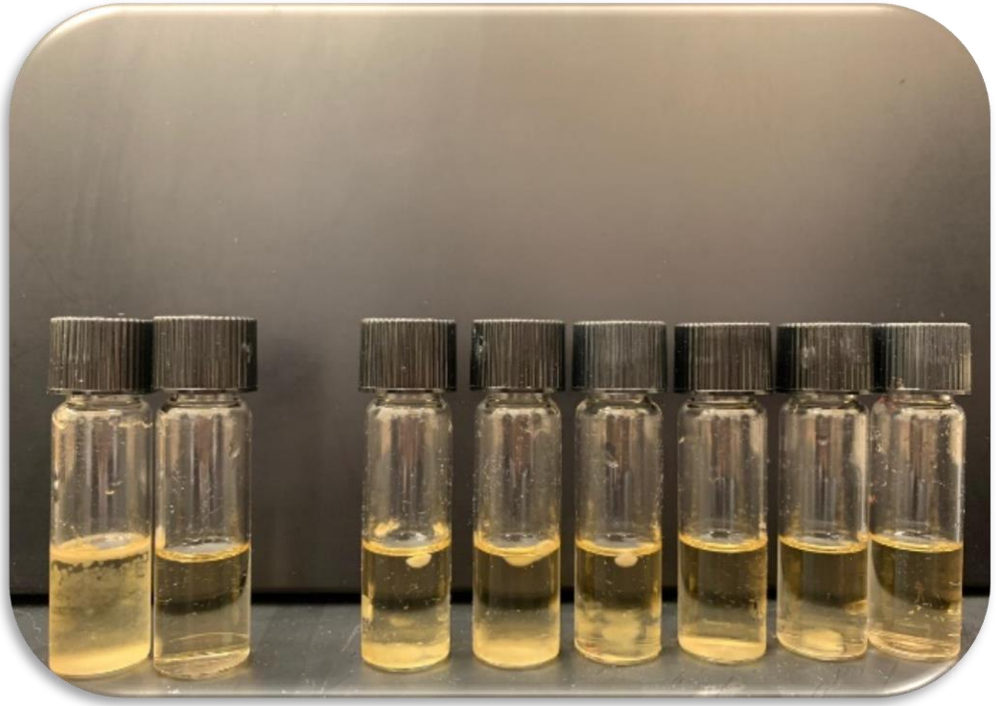
Results

Agar plates collected off the six-stage cascade impactor after 30 sec. of applying different air cleaning devices





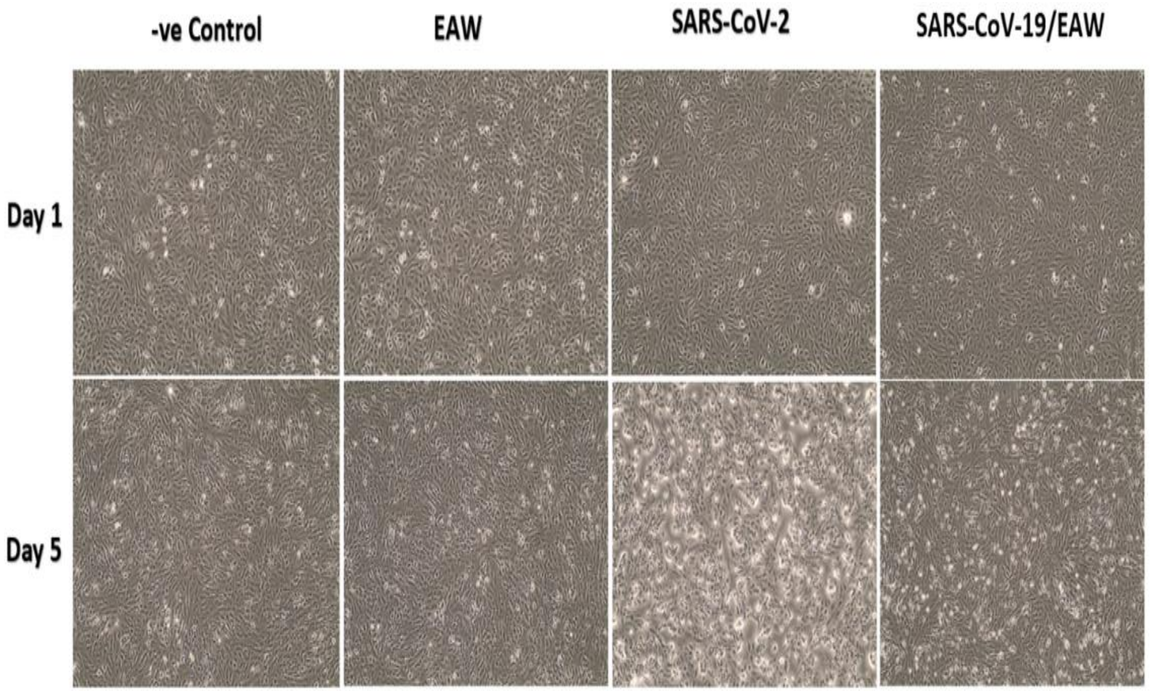
Air cleaning efficacy of the three devices at different cleaning periods



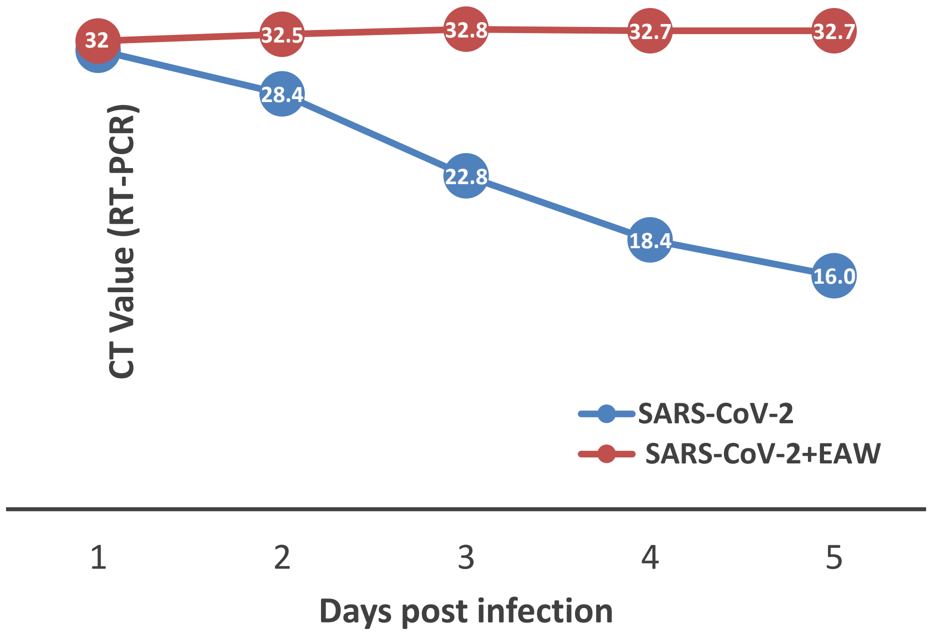
Effect of EAW on fungus (A. niger)


BRC
BIOMEDICAL RESEARCH CENTER
مركز البحوث الحيوية الطبية
CERTEK
جامعة قطر
QATAR UNIVERSITY

Results

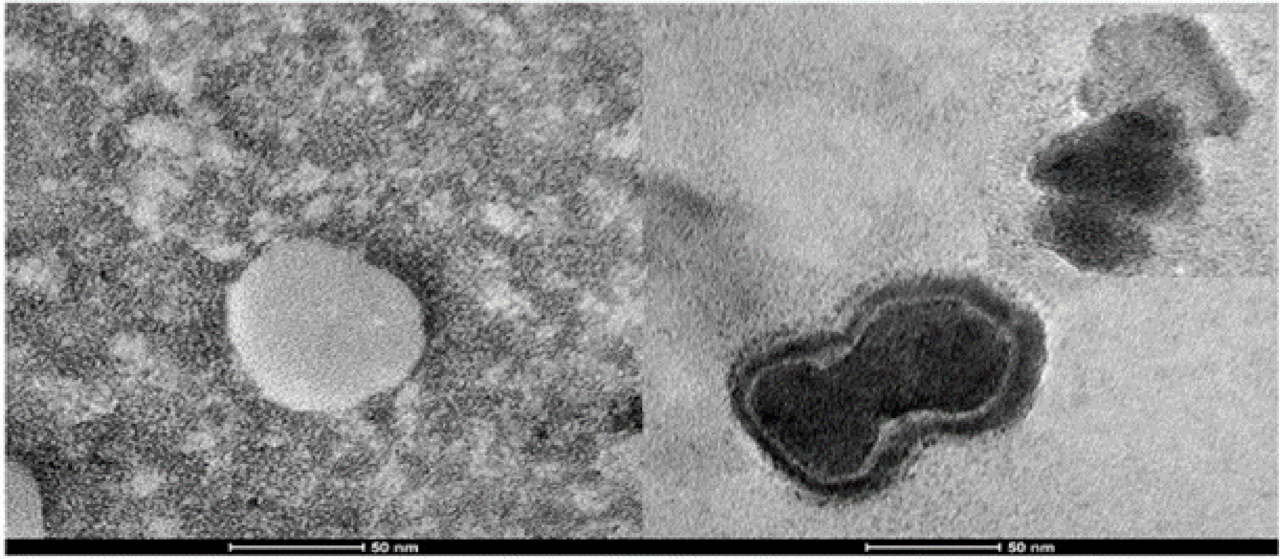


The effect of EAW on SARS-CoV-19 under an inverted microscope



Effect of EAW on SARS-CoV-2 using RT-qPCR

Results



SARS-CoV-2 virus treated with the electrolyzed water

Results

"As for the air sampling there was more than 80% reduction for the level of bacterial contamination"

Department of Laboratory Medicine and Pathology

Hamad Medical Corporation

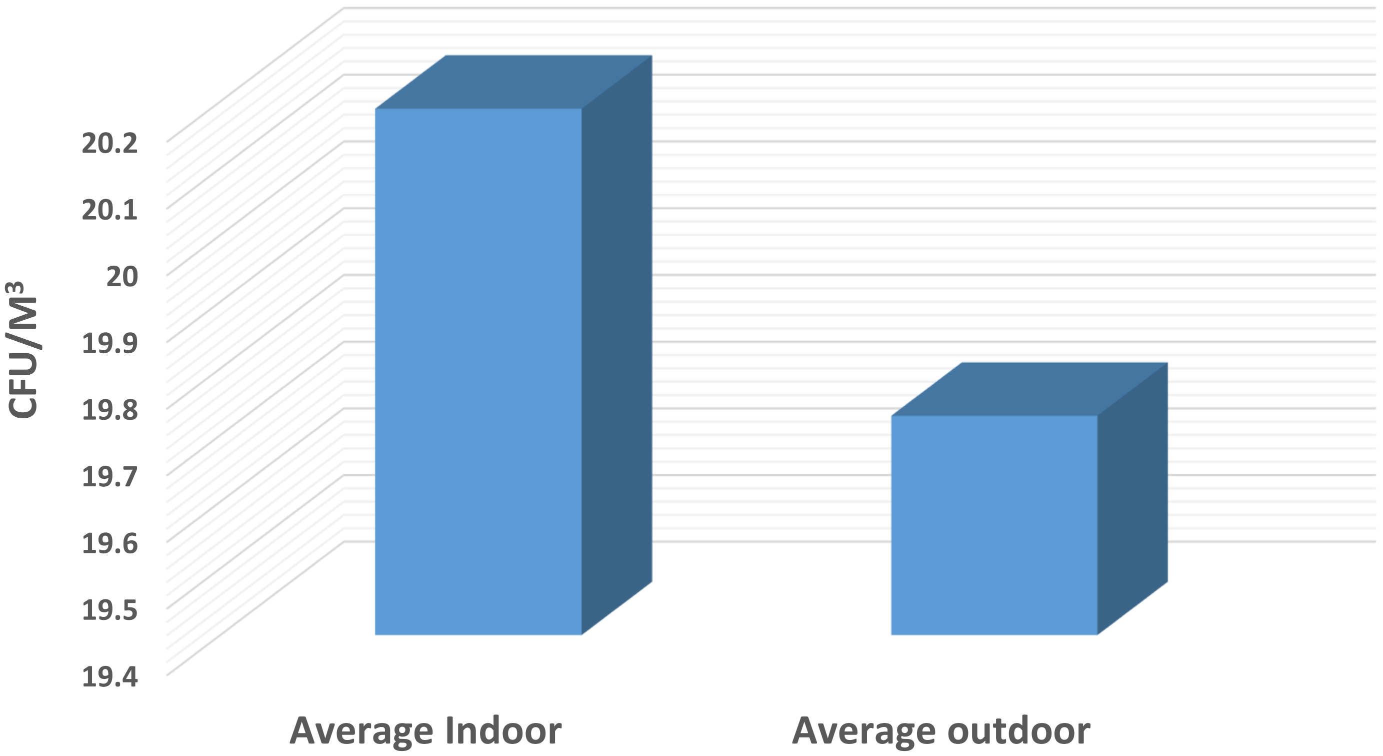
ENVIRONMENTAL SCREENING REPORT

Laboratory Section: Microbiology

SPECIMEN TYPE	:	Air Sampling
LOCATION	:	RH-Enaya-F1-Room111
COLLECTION DATE	:	27/07/2020
COLLECTION TIME	:	11:49 am
COLLECTED BY	:	Joji -ICP
DETAILS	:	Hepa Filter Machine testing (Post – Test)

RESULTS :	**Level of Bacterial contamination = 16 Cfu/m³**
	10 Micrococcus species
	6 Coagulases Negative Staphylococcus
	Level of Fungal contamination = 1 Cfu/m³
	Aspergillus species
INTERPRETATION:	There are no data on conidial levels that may be considered to be normal, but concentrations >25 CFU/m³ are very high and are associated with an increase in the number of cases of IA among patients with risk factors

Results



Total average CFU/M² during Dec. 19- March 20 in 4 PHCC

Conclusions

- **Our air novel cleaning prototype device exhibited efficiency using SARS –CoV-2, Newcastle virus, *E. coli*, and *Aspergillus* at laboratory level.**

- **The technology showed its efficacy at health facility level as well.**

- **The application is novel, marketable and will have a global impact not on hospitals’ infection control strategies only but in all indoor public places.**

Food and Beverage Industry

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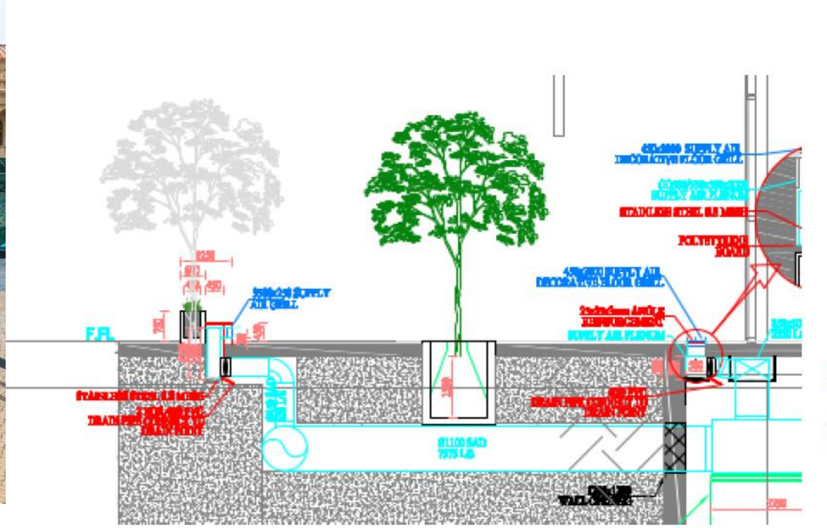
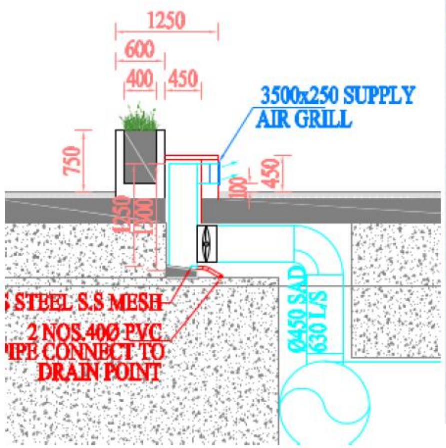
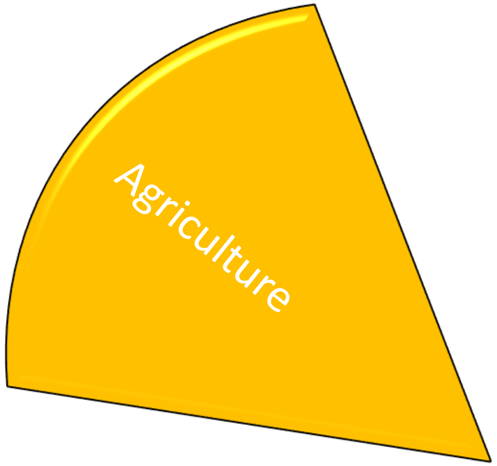
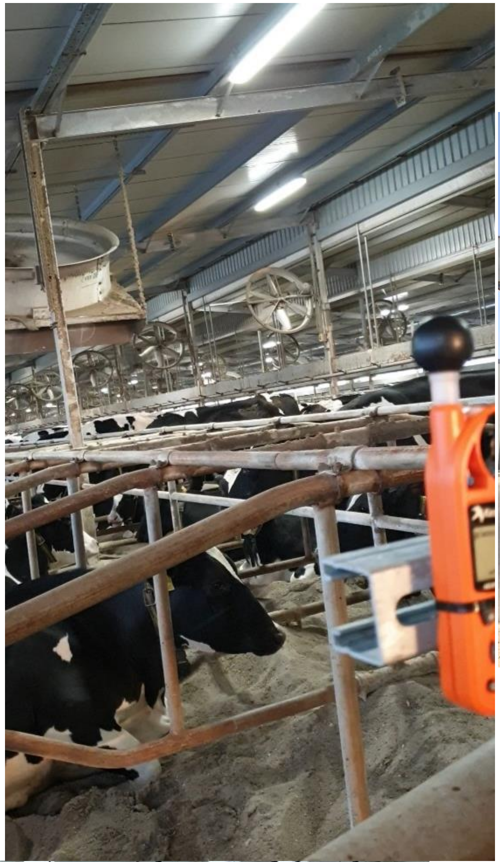


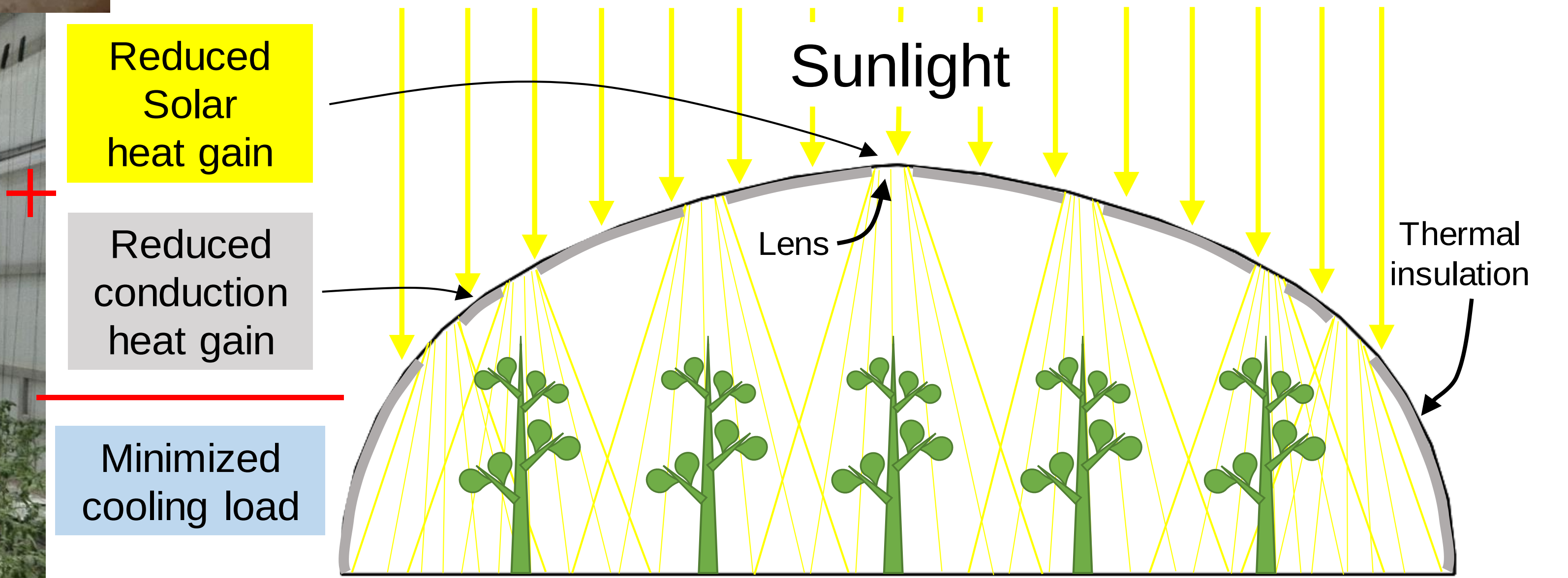



Agriculture

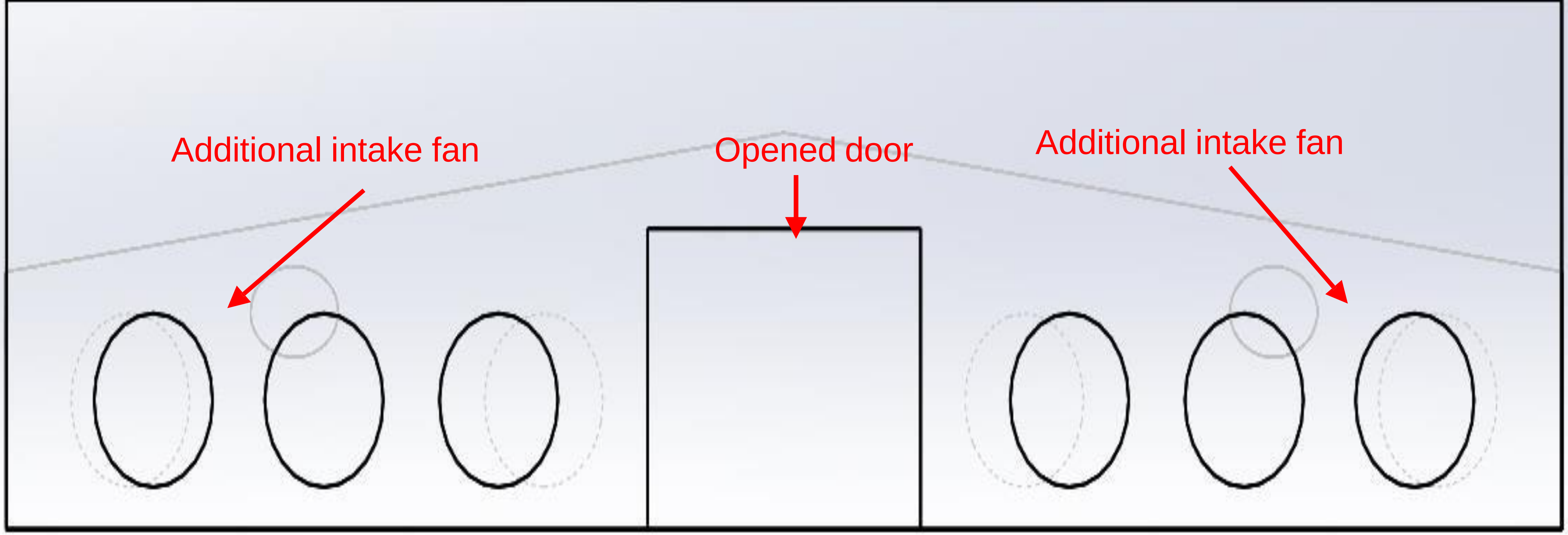



MB15 -16
Barn 12 Front

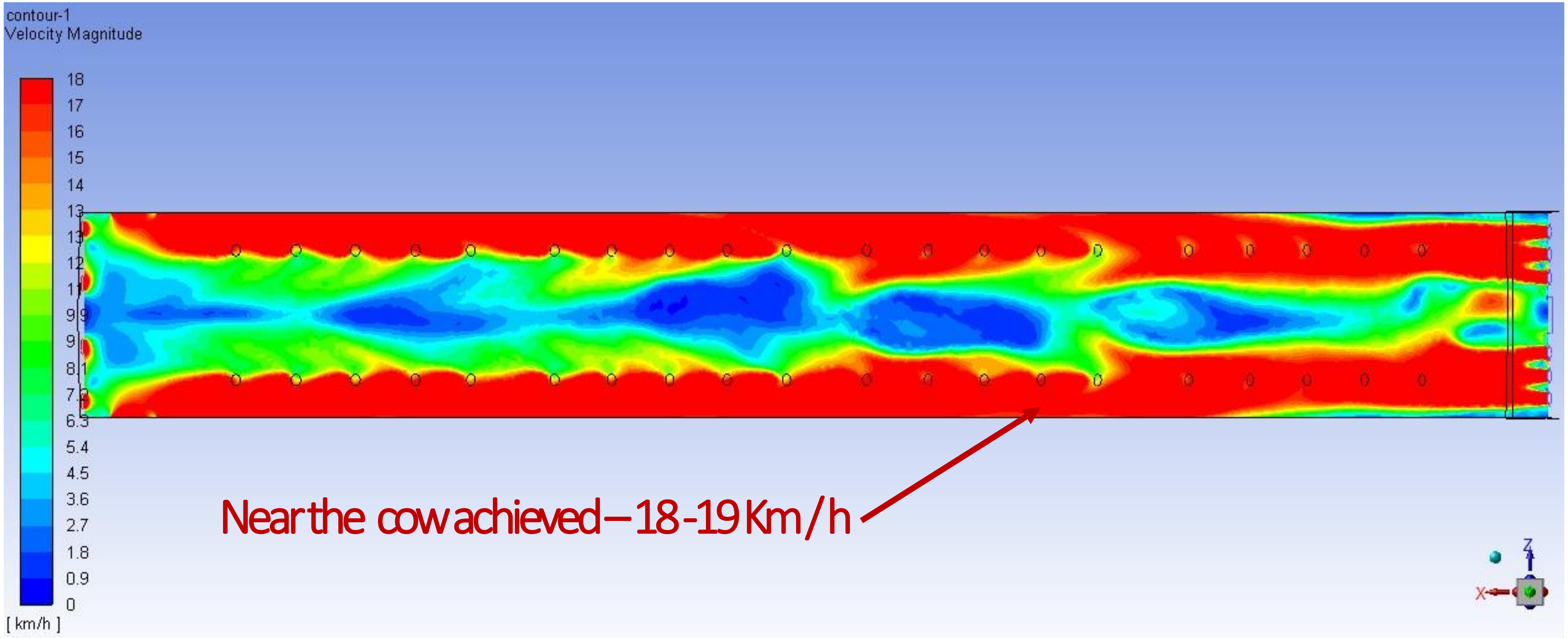

Barn 12 Back


Reduced Solar heat gain
+
Reduced conduction heat gain
Minimized cooling load
Sunlight
Lens
Thermal insulation

Fan Arrangement



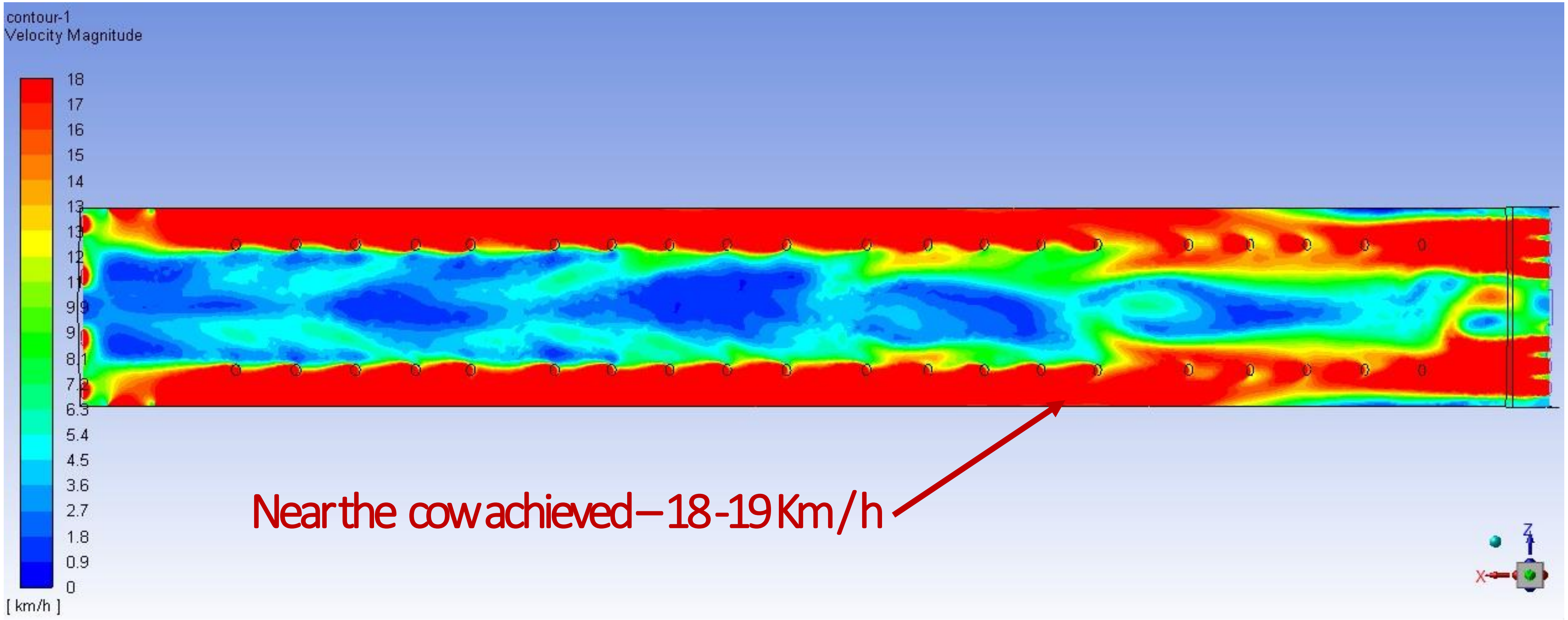
Case B : Velocity contours, horizontal plane, height = 1 m, v_{max} = 18 km/h



Baffle	Exhaust Fans	Free Stall Fans (F1)	Feed Lane Fans (F2)	Intake Fans(F3)	Side Wall Fans(F4)
NON ACTIVE	RUNNING	RUNNING	-	RUNNING	-

Ventilation Flow rate (m^3/S)	Sec/Air Exchange	Average Velocity over the stalls are at 1m Height (km/hr)
355	95	18

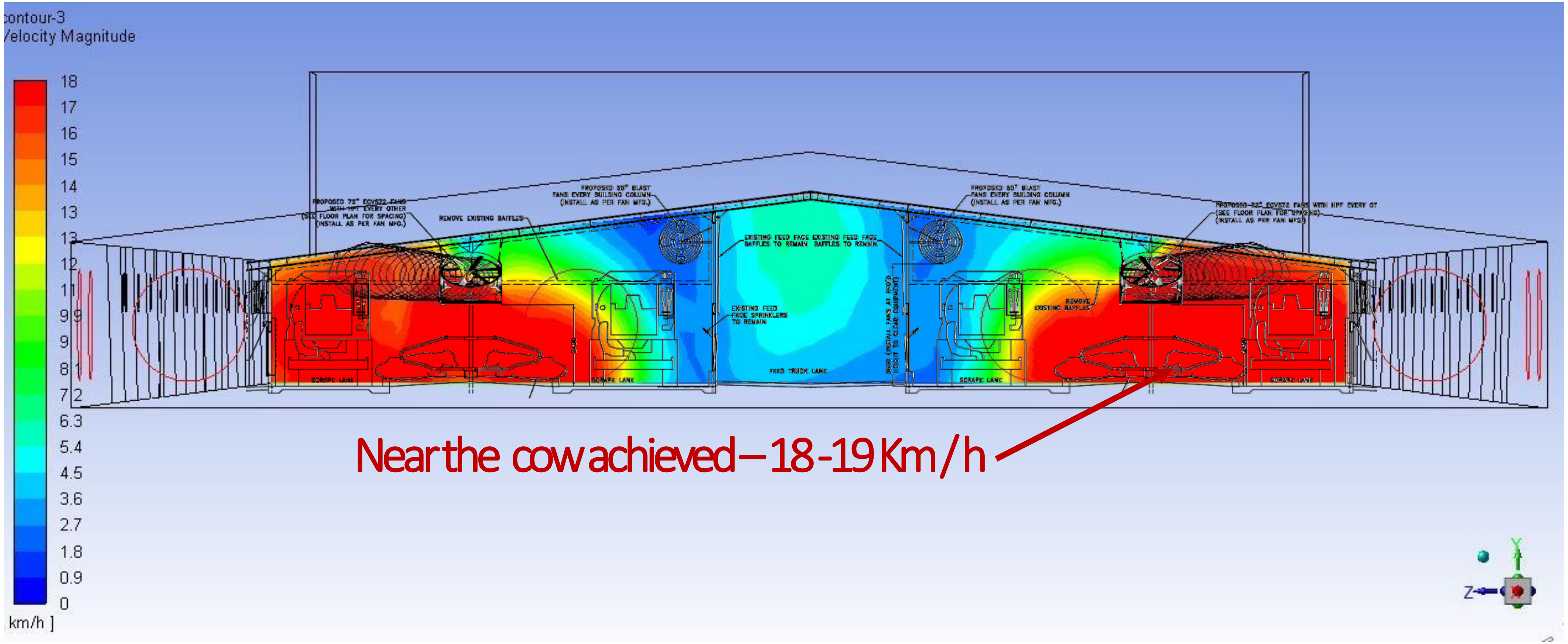
Case#4.2: Velocity contours, horizontal plane, height = 2 m, v_{max} = 18 km/h



Baffle	Exhaust Fans	Free Stall Fans (F1)	Feed Lane Fans (F2)	Intake Fans(F3)	Side Wall Fans(F4)
NON ACTIVE	RUNNING	RUNNING	-	RUNNING	-

Ventilation Flow rate (m^3/S)	Sec/Air Exchange	Average Velocity over the stalls are at 1m Height (km/hr)
355	95	18

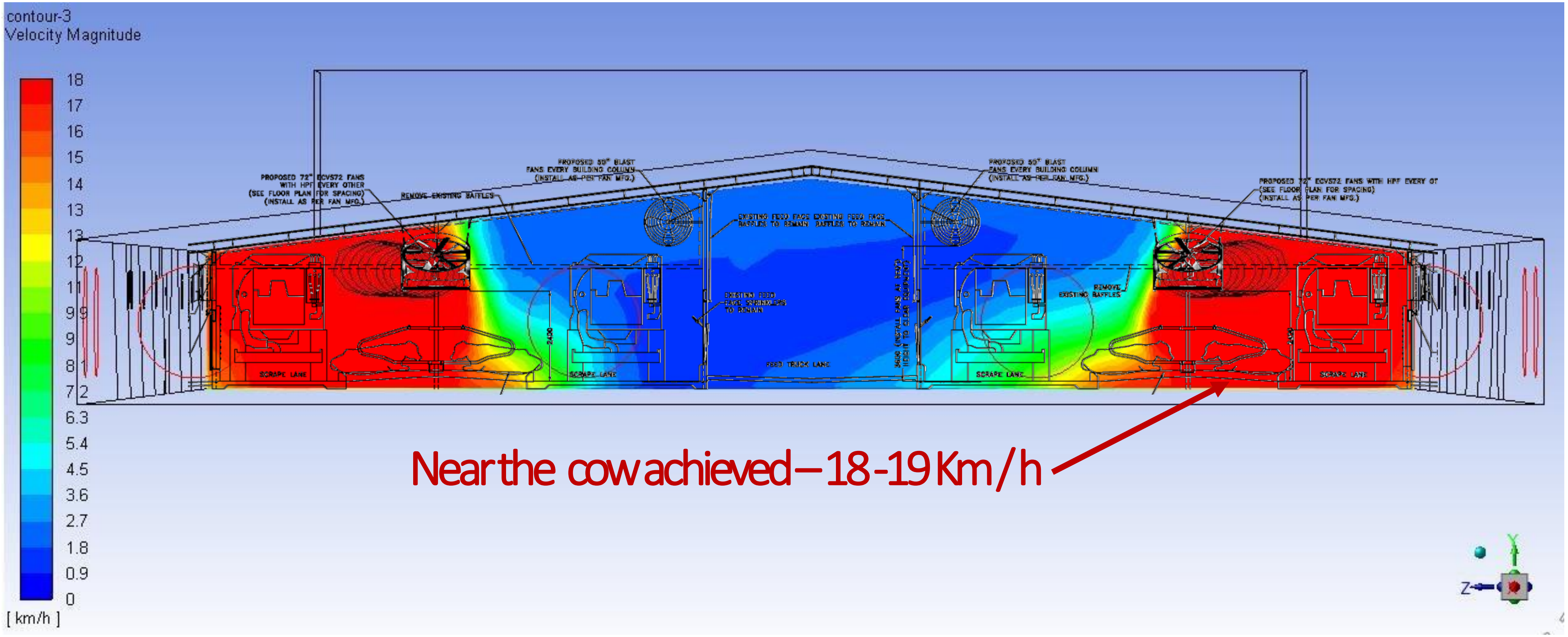
Case B : Velocity contours, vertical plane 1, v_{max} = 18 km/h



Baffle	Exhaust Fans	Free Stall Fans (F1)	Feed Lane Fans (F2)	Intake Fans(F3)	Side Wall Fans(F4)
NON ACTIVE	RUNNING	RUNNING	-	RUNNING	-

Ventilation Flow rate (m^3/S)	Sec/Air Exchange	Average Velocity over the stalls are at 1m Height (km/hr)
355	95	18

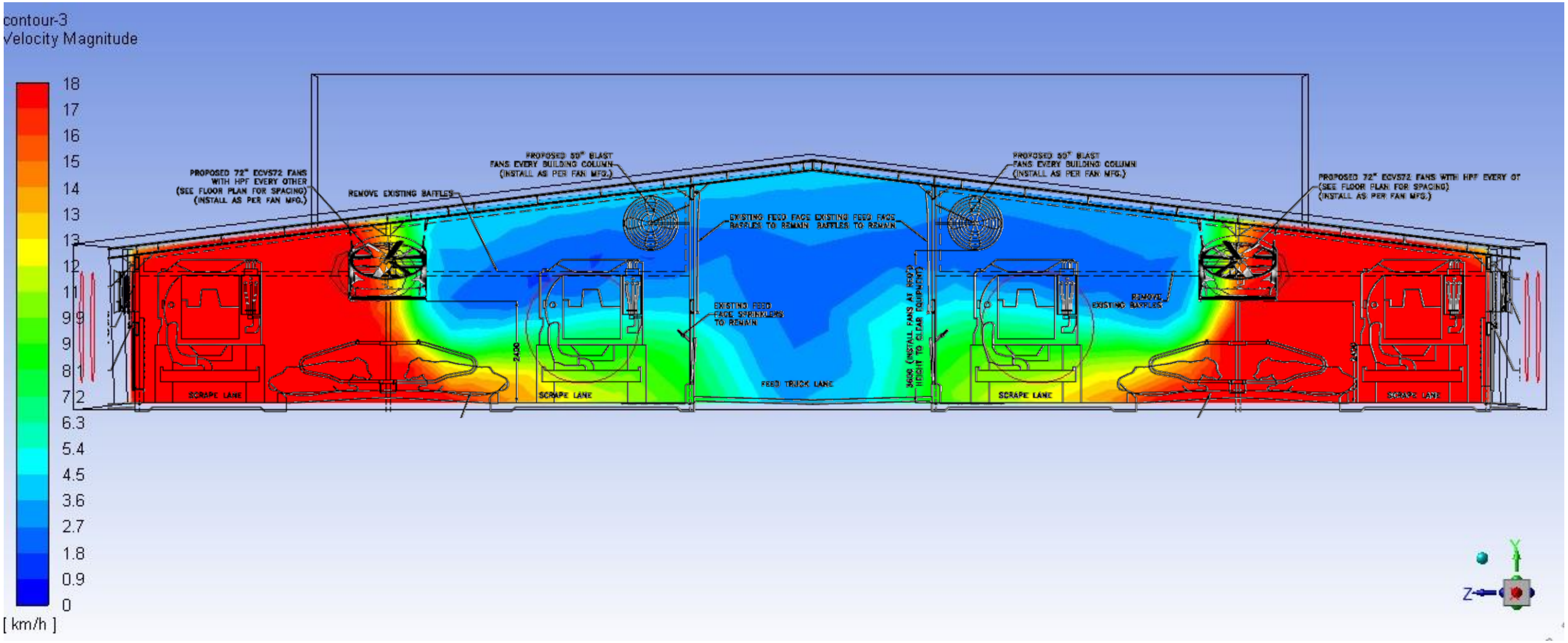
Case B: Velocity contours, vertical plane 2, $v_{max} = 18$ km/h



Baffle	Exhaust Fans	Free Stall Fans (F1)	Feed Lane Fans (F2)	Intake Fans(F3)	Side Wall Fans(F4)
NON ACTIVE	RUNNING	RUNNING	-	RUNNING	-

Ventilation Flow rate (m^3/S)	Sec/Air Exchange	Average Velocity over the stalls are at 1m Height (km/hr)
355	95	18

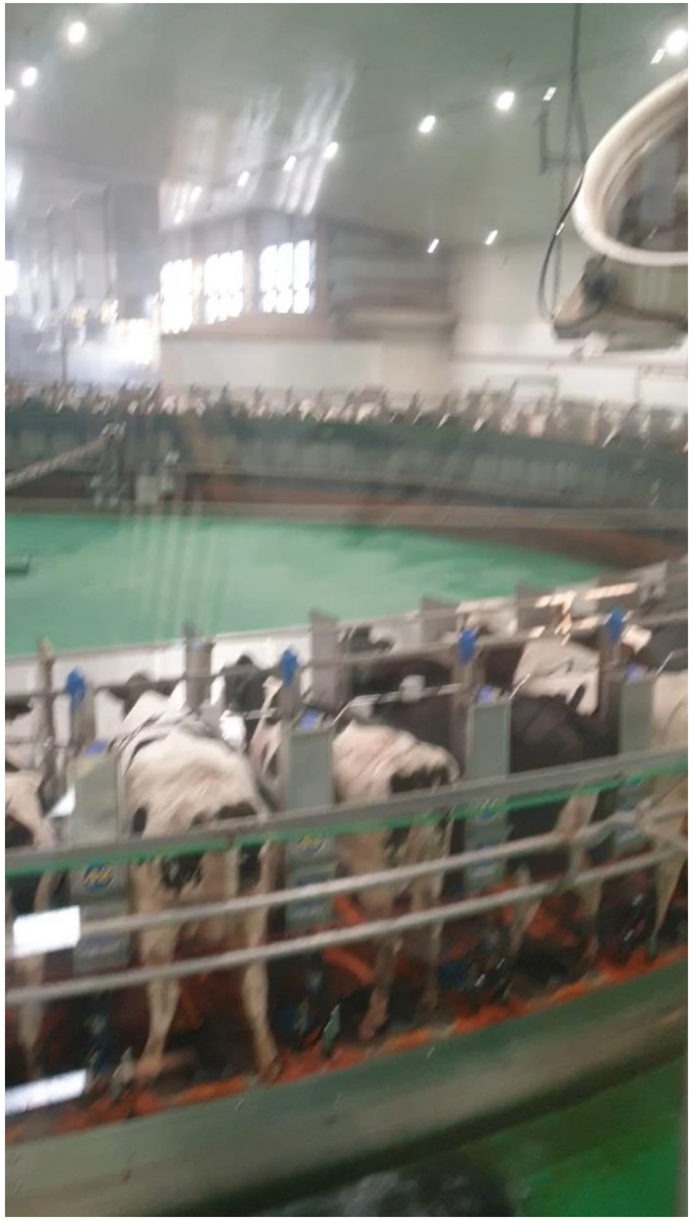
Case B : Velocity contours, vertical plane 3, v_{max} = 18 km/h



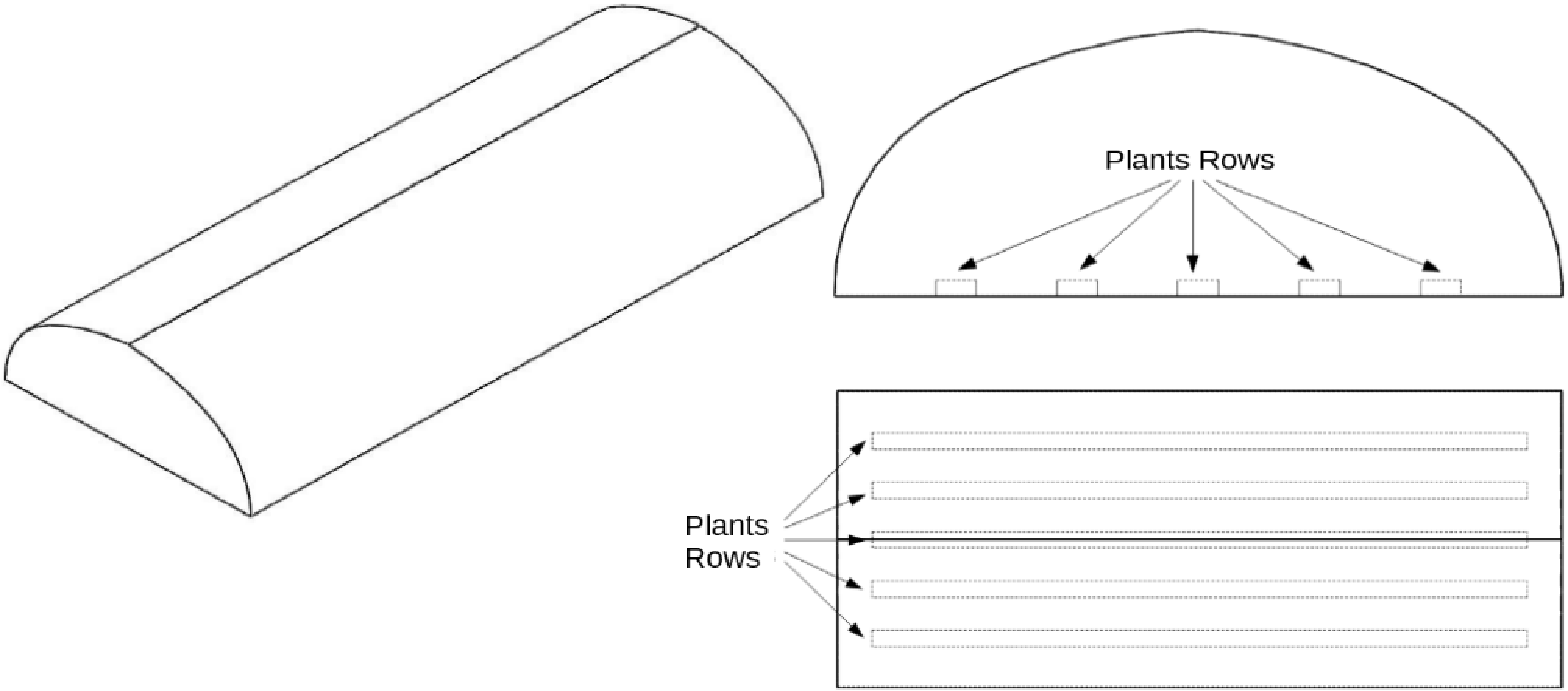
Baffle	Exhaust Fans	Free Stall Fans (F1)	Feed Lane Fans (F2)	Intake Fans(F3)	Side Wall Fans(F4)
NON ACTIVE	RUNNING	RUNNING	-	RUNNING	-

Ventilation Flow rate (m^3/S)	Sec/Air Exchange	Average Velocity over the stalls are at 1m Height (km/hr)
355	95	18

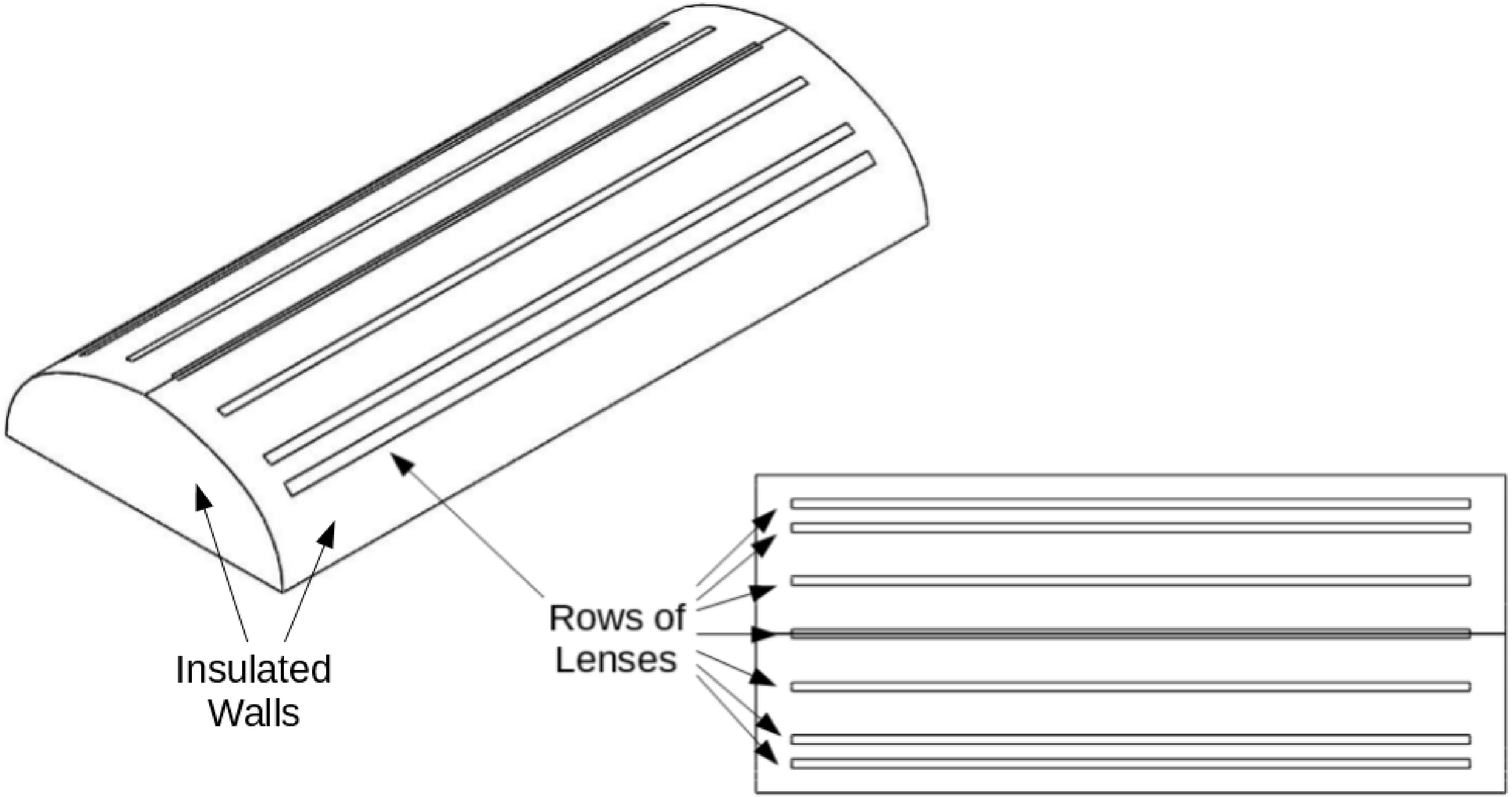
Video



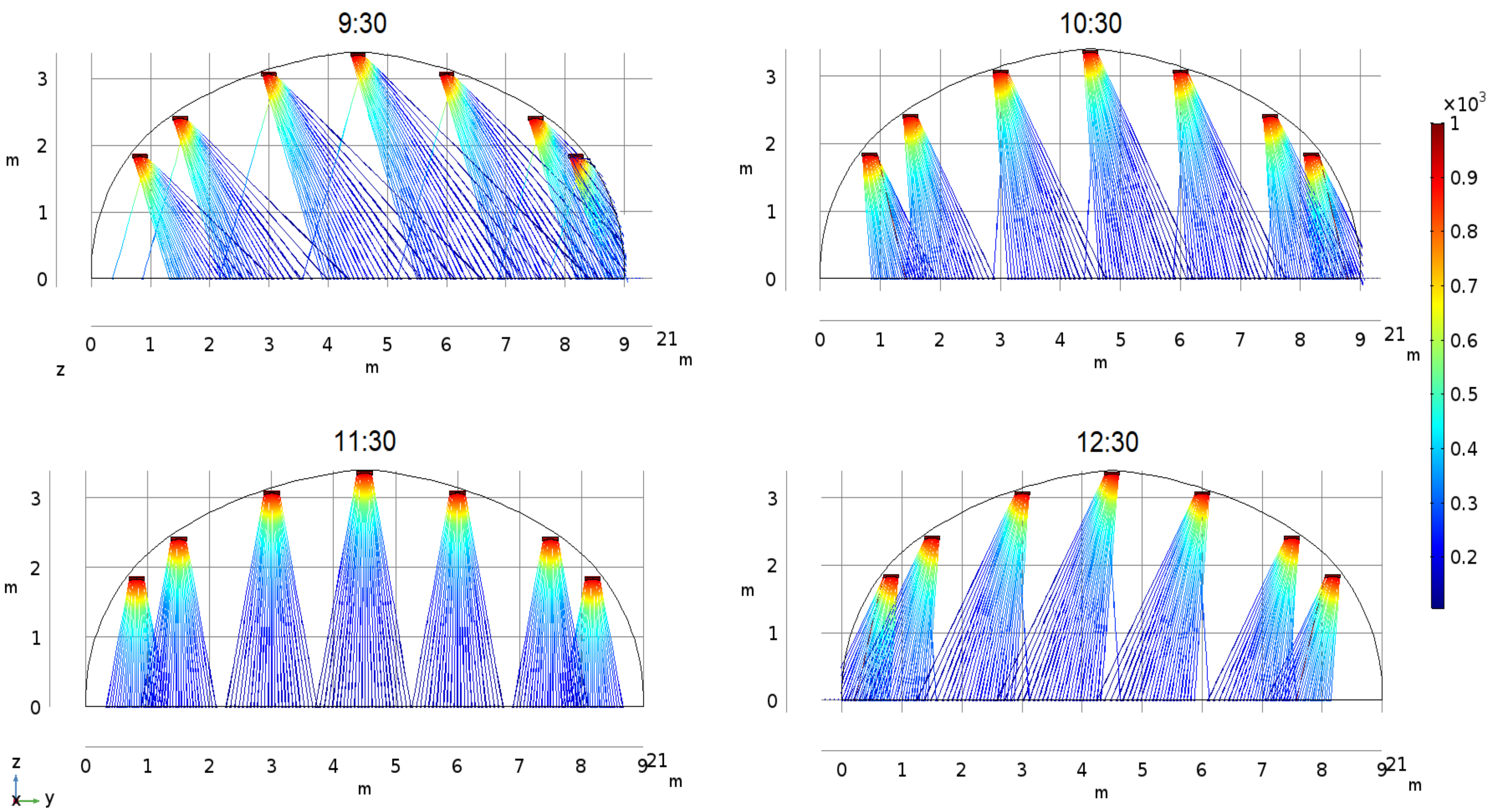
Current Greenhouse



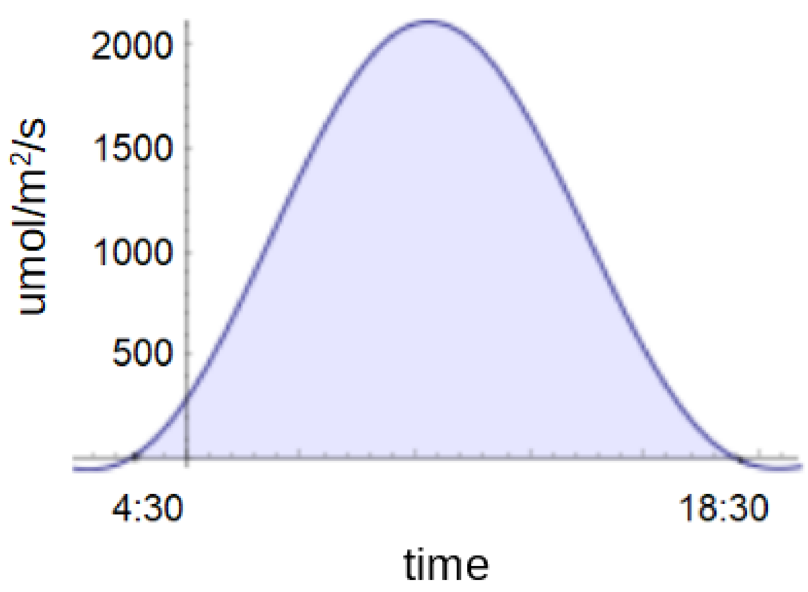
Designed Greenhouse

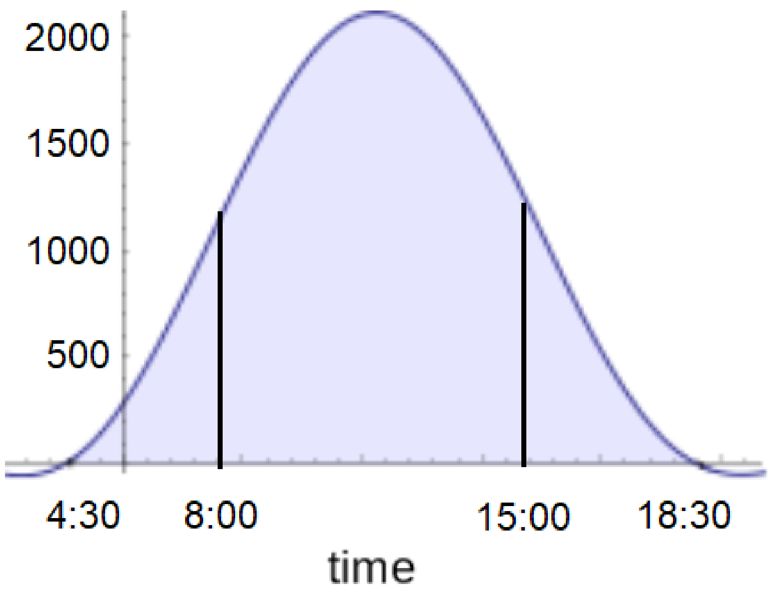


Sun Ray Trajectories



Average DLI during Summer

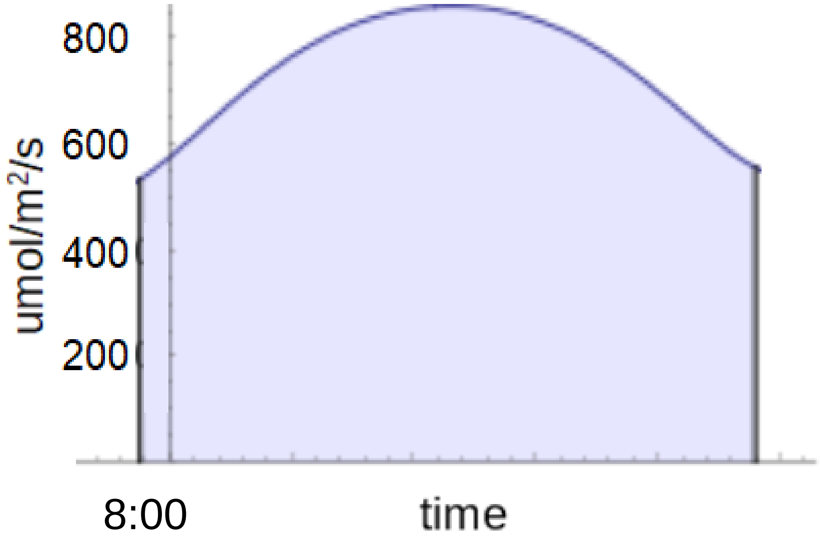




From 4:30 to 18:30
DLI = 59 mol/m^2

From 8:00 to 15:00
DLI = 45 mol/m^2

DLI inside the Designed Greenhouse – June

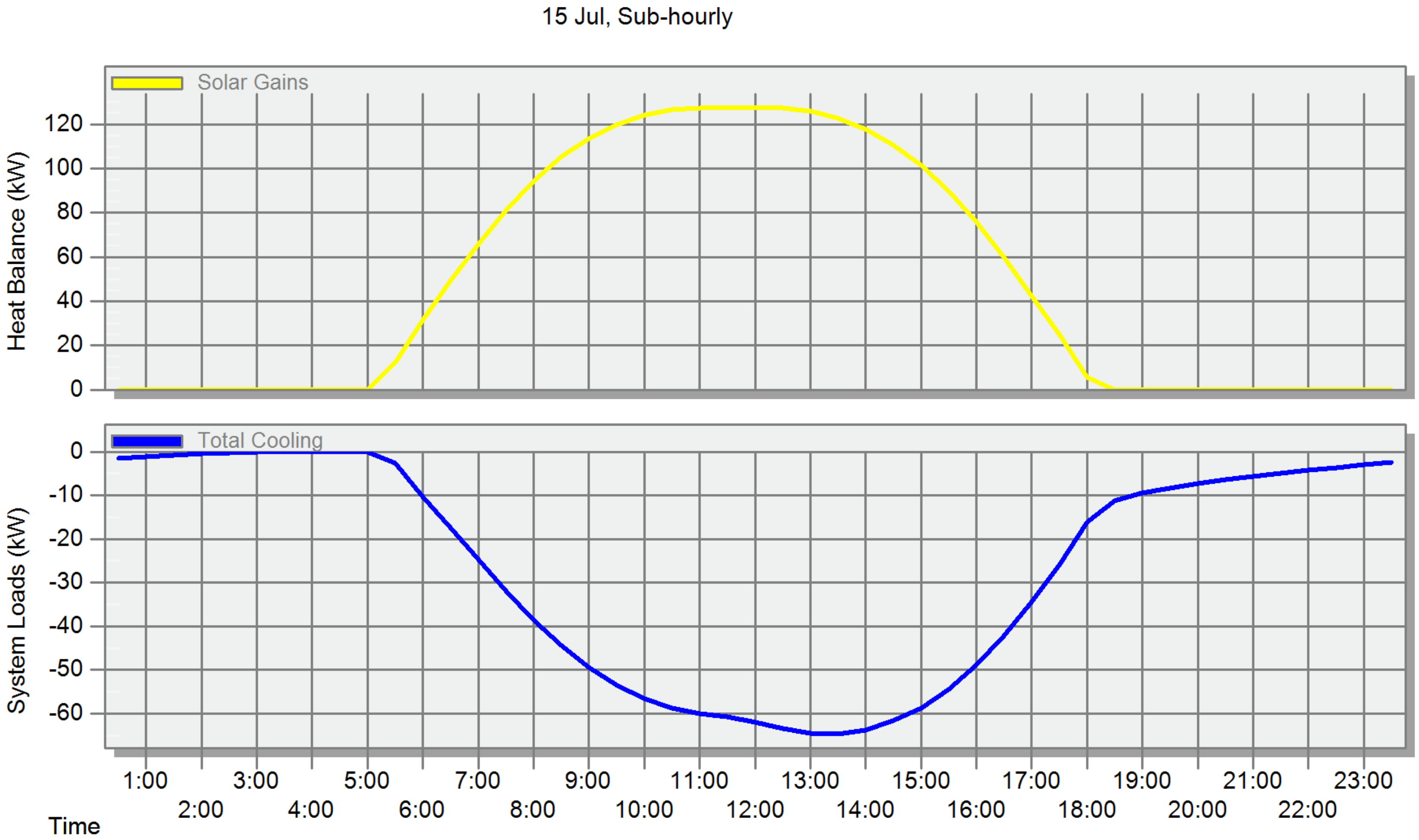


15:00

From 8:00 to 15:00

DLI = 18 mol/m^2

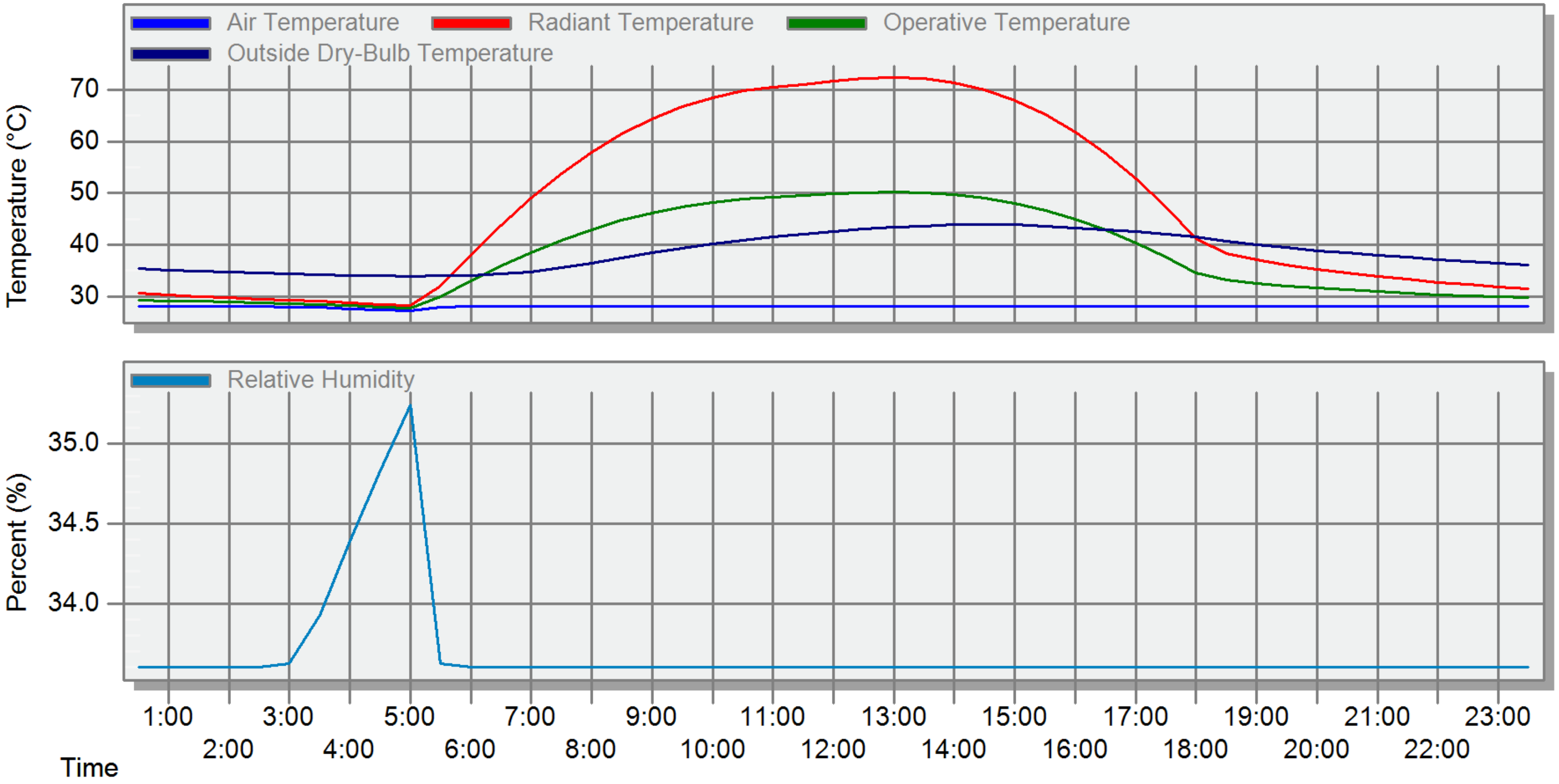
Current Greenhouse – Solar Gain and Cooling Load – Transmission=70%



Time	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Solar Gains	0.00	0.00	0.00	0.00	0.00	31.34	65.93	94.36	113.50	124.09	127.45	127.47	125.81	117.71	101.41	75.75	42.55	5.44	0.00	0.00	0.00	0.00	0.00
Total Cooling	-1.16	-0.51	0.00	0.00	0.00	-10.41	-24.74	-38.52	-49.38	-56.60	-59.98	-61.98	-64.52	-63.74	-58.71	-48.87	-34.52	-16.16	-9.54	-7.28	-5.67	-4.22	-3.05

Current Greenhouse – Temperature and Humidity – Transmission=70%

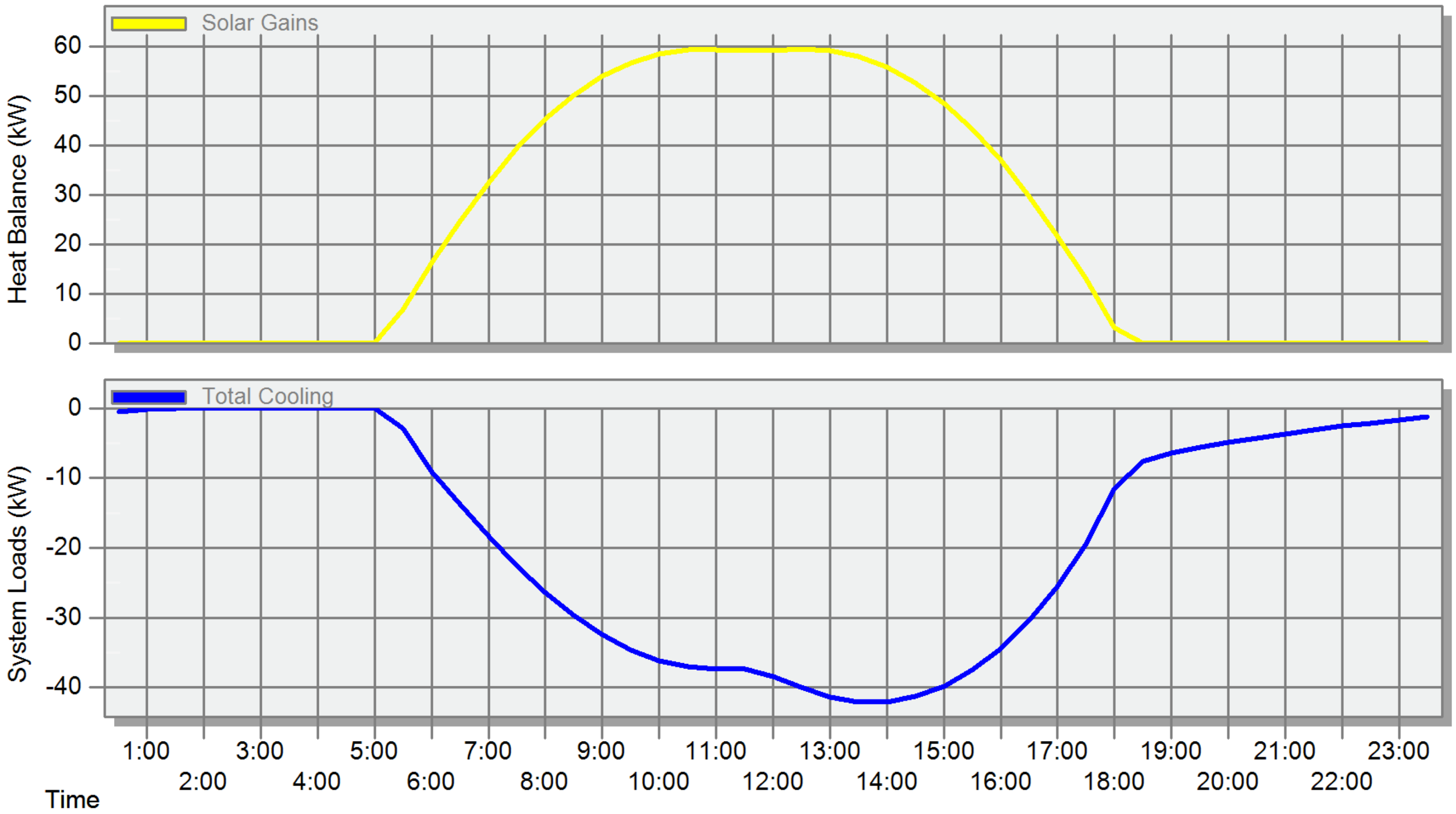
15 Jul, Sub-hourly



Air Temperature	28.00	28.00	27.99	27.60	27.18	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00
Radiant Temperature	30.33	29.75	29.25	28.75	28.23	38.14	49.12	57.91	64.39	68.55	70.58	71.65	72.45	71.38	67.98	61.83	52.87	41.13	37.12	35.27	33.88	32.74	31.83
Operative Temperature	29.16	28.87	28.62	28.18	27.71	33.07	38.56	42.96	46.19	48.27	49.29	49.83	50.22	49.69	47.99	44.91	40.43	34.56	32.56	31.64	30.94	30.37	29.91
Outside Dry-Bulb Temperature	35.10	34.70	34.40	34.10	33.90	34.10	34.80	36.50	38.40	40.10	41.60	42.60	43.40	43.90	43.90	43.30	42.50	41.50	40.00	38.90	38.00	37.10	36.40
Relative Humidity	33.60	33.60	33.62	34.39	35.24	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60

Current Greenhouse – Solar Gain and Cooling Load – Transmission=30%

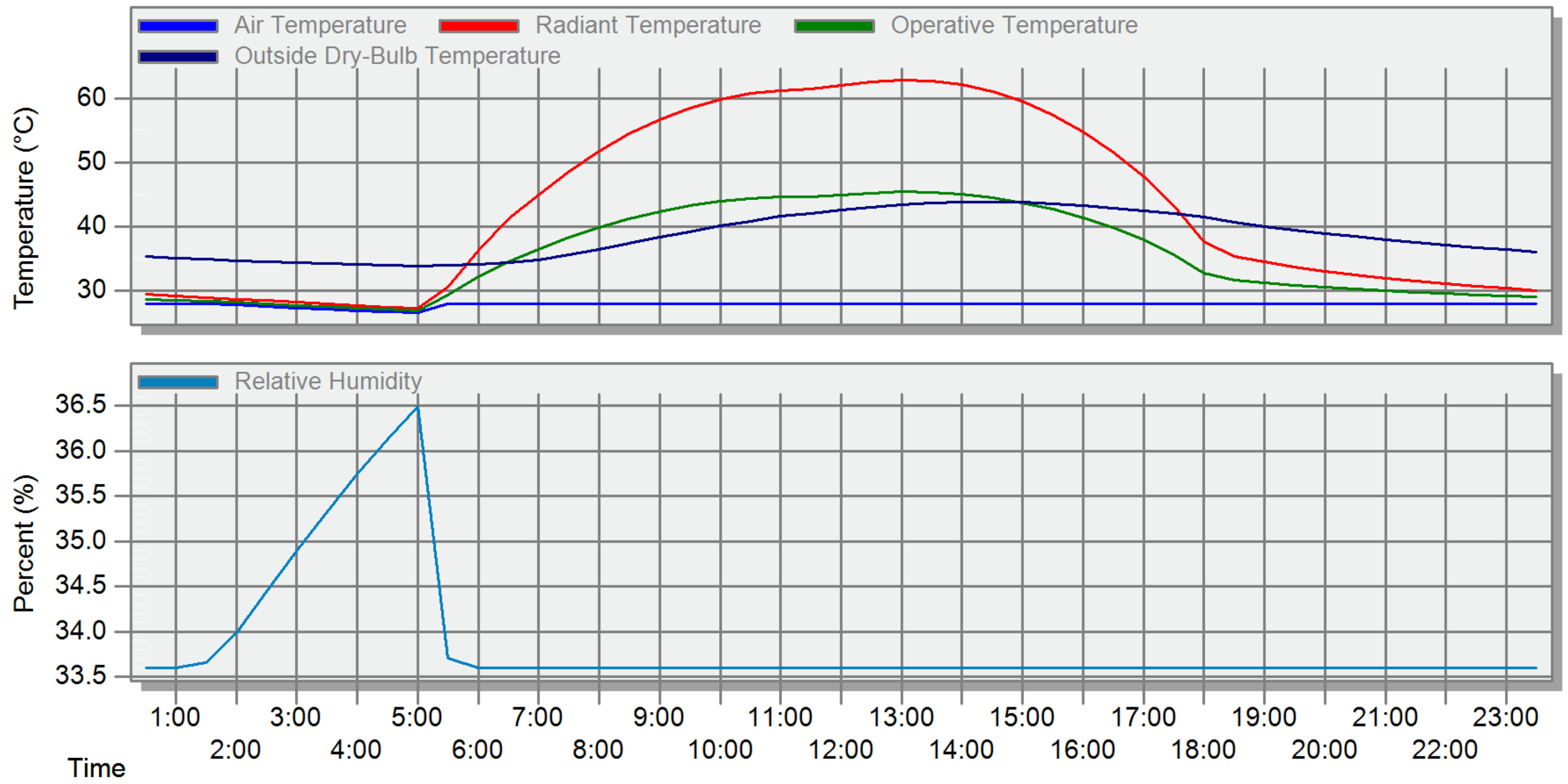
15 Jul, Sub-hourly



Solar Gains	0.00	0.00	0.00	0.00	0.00	16.33	32.44	45.34	53.92	58.52	59.42	59.26	59.14	55.80	48.51	36.92	21.65	3.02	0.00	0.00	0.00	0.00	0.00
Total Cooling	-0.21	0.00	0.00	0.00	0.00	-9.12	-18.37	-26.41	-32.46	-36.23	-37.34	-38.40	-41.34	-42.05	-39.84	-34.42	-25.53	-11.48	-6.46	-4.91	-3.71	-2.59	-1.69

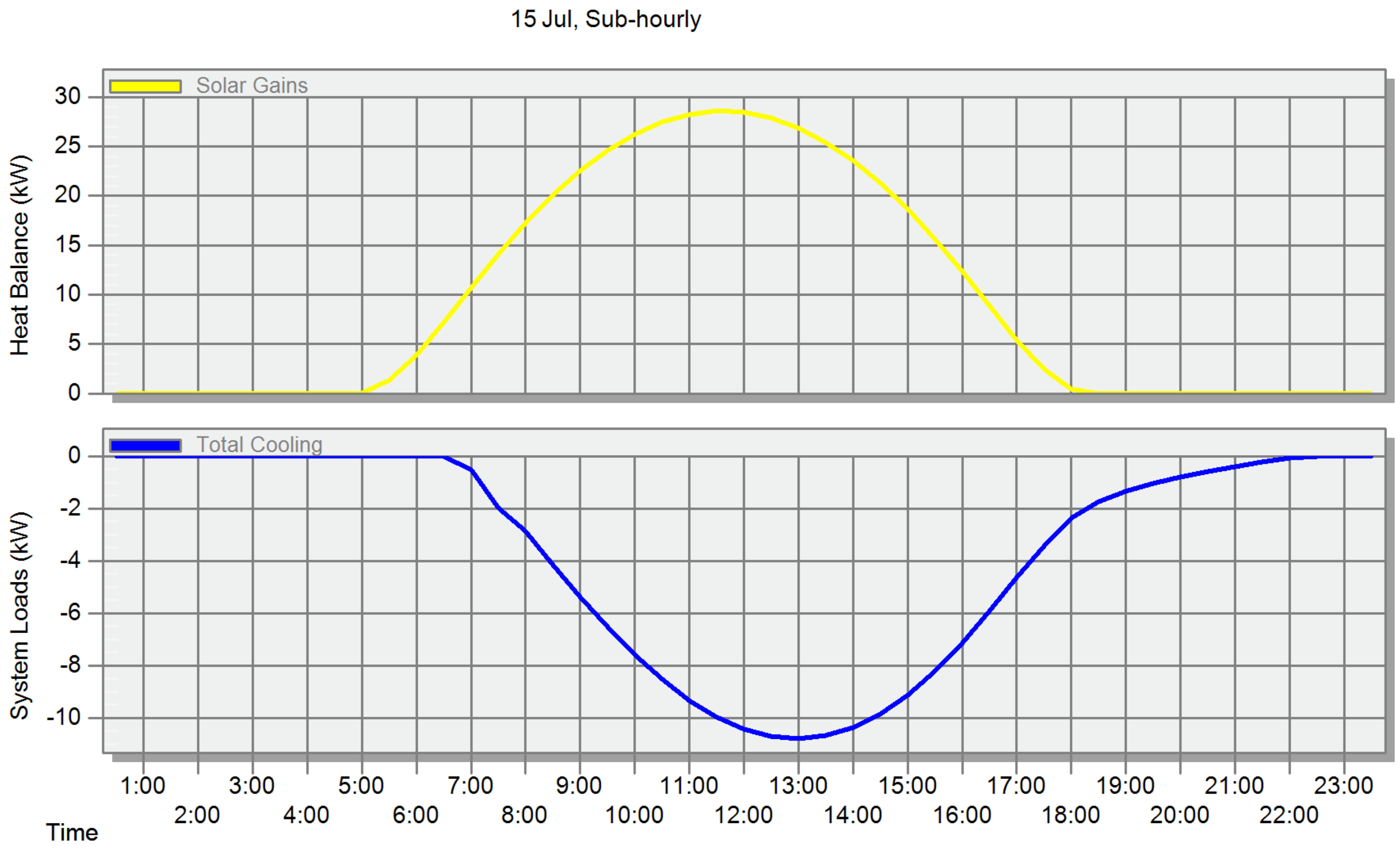
Current Greenhouse – Temperature and Humidity – Transmission=30%

15 Jul, Sub-hourly



Air Temperature	28.00	27.80	27.35	26.94	26.59	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00
Radiant Temperature	29.19	28.72	28.22	27.72	27.29	36.38	44.99	51.73	56.70	59.88	61.21	61.95	62.86	62.14	59.51	54.83	47.86	37.64	34.48	33.08	32.01	31.13	30.40
Operative Temperature	28.60	28.26	27.79	27.33	26.94	32.19	36.49	39.86	42.35	43.94	44.60	44.98	45.43	45.07	43.76	41.42	37.93	32.82	31.24	30.54	30.01	29.56	29.20
Outside Dry-Bulb Temperature	35.10	34.70	34.40	34.10	33.90	34.10	34.80	36.50	38.40	40.10	41.60	42.60	43.40	43.90	43.90	43.30	42.50	41.50	40.00	38.90	38.00	37.10	36.40
Relative Humidity	33.60	33.99	34.89	35.75	36.49	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60

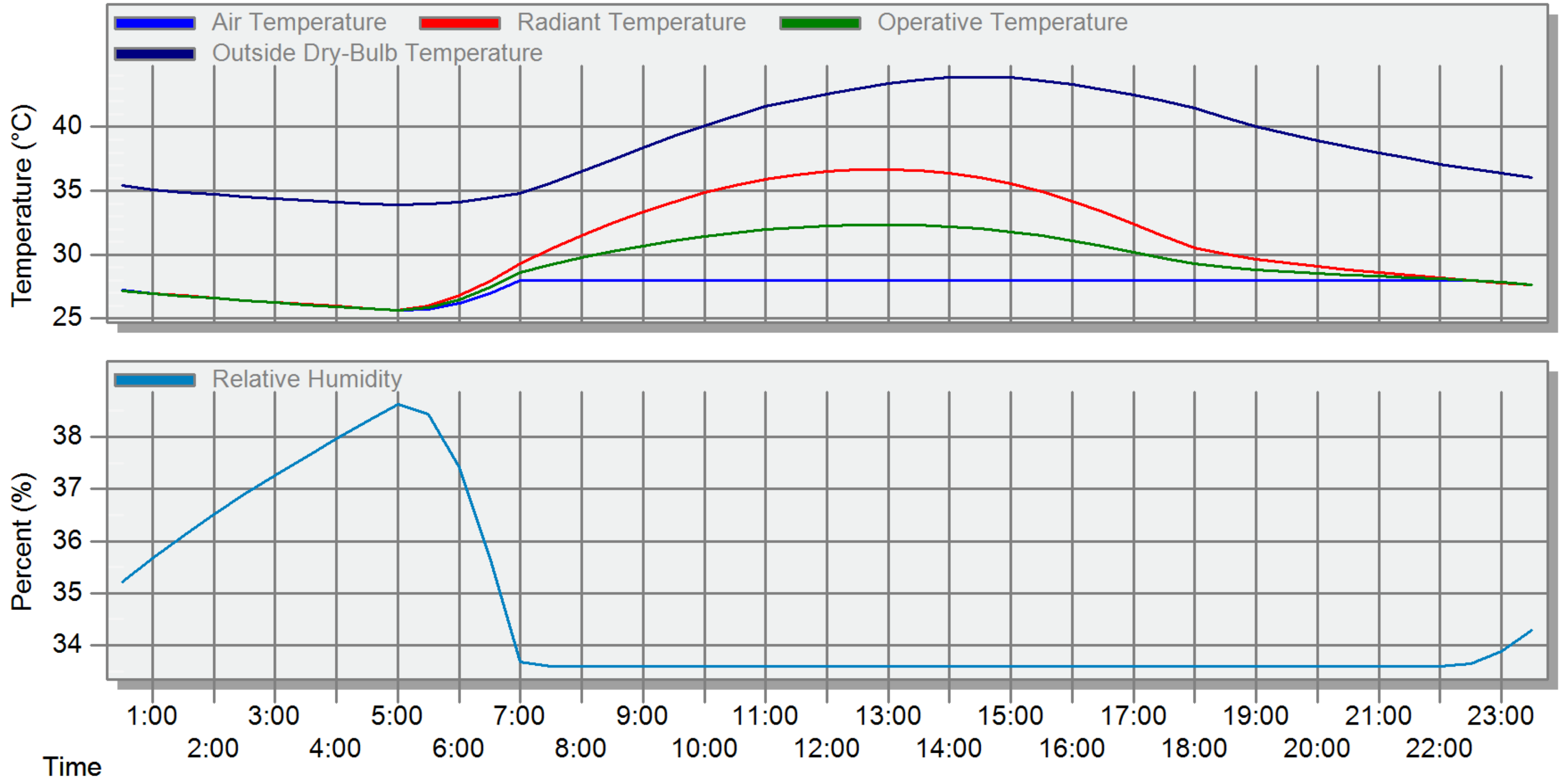
Designed Greenhouse – Solar Gain and Cooling Load



Solar Gains	0.00	0.00	0.00	0.00	0.01	3.92	10.71	17.25	22.55	26.26	28.27	28.49	26.89	23.59	18.65	12.35	5.43	0.41	0.00	0.00	0.00	0.00	0.00
Total Cooling	0.00	0.00	0.00	0.00	0.00	0.00	-0.52	-2.85	-5.37	-7.59	-9.33	-10.42	-10.78	-10.37	-9.14	-7.14	-4.65	-2.37	-1.35	-0.80	-0.41	-0.09	0.00

Designed Greenhouse – Temperature and Humidity

15 Jul, Sub-hourly



Air Temperature	26.98	26.58	26.24	25.92	25.63	26.17	27.96	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	27.86
Radiant Temperature	26.99	26.61	26.27	25.96	25.68	26.80	29.27	31.50	33.35	34.84	35.91	36.52	36.69	36.38	35.55	34.19	32.39	30.55	29.66	29.08	28.62	28.20	27.82
Operative Temperature	26.98	26.60	26.26	25.94	25.66	26.48	28.61	29.75	30.68	31.42	31.96	32.26	32.34	32.19	31.78	31.09	30.19	29.27	28.83	28.54	28.31	28.10	27.84
Outside Dry-Bulb Temperature	35.10	34.70	34.40	34.10	33.90	34.10	34.80	36.50	38.40	40.10	41.60	42.60	43.40	43.90	43.90	43.30	42.50	41.50	40.00	38.90	38.00	37.10	36.40
Relative Humidity	35.67	36.51	37.26	37.96	38.62	37.41	33.68	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.88

Comparison – Transmission=30%

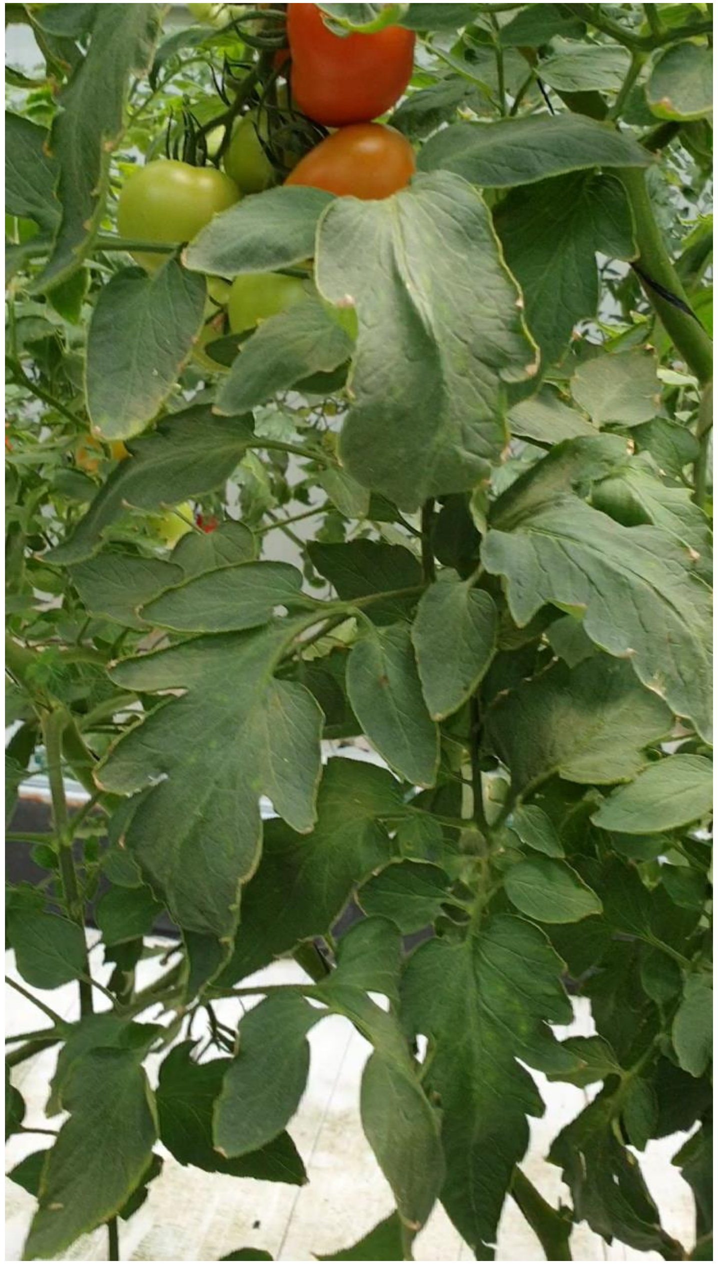
	Current Greenhouse, T=30%	Designed Greenhouse
Maximum Solar Gain, *kW*	59.42	28.49
Maximum Cooling Load, *kW*	42.05	10.78
Daily Light Integral, *mol/m²*	13.5	18

Comparison – Transmission=70%

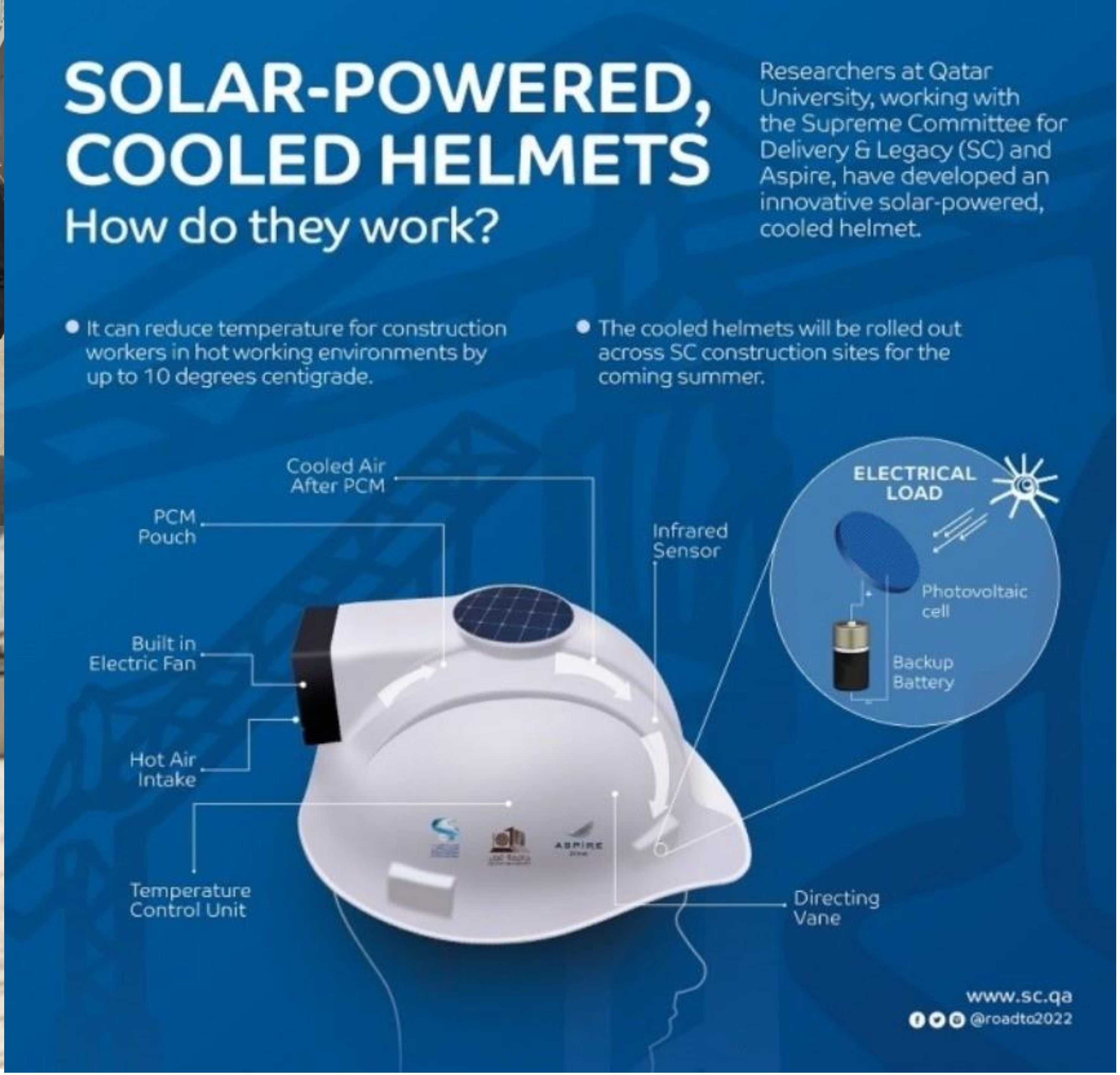
	Current Greenhouse, T=70%	Designed Greenhouse
Maximum Solar Gain, *kW*	127.47	28.49
Maximum Cooling Load, *kW*	64.52	10.78
Daily Light Integral, *mol/m*^{2}	31.5	18

Capital Cost

Item	Quantity	Unit Price, $	Extended, $
Lens Mold	1	1,500	1,500
Lens	550	4.50	2,475
Weather Station	3	3,365	10,095
		Total	14,070

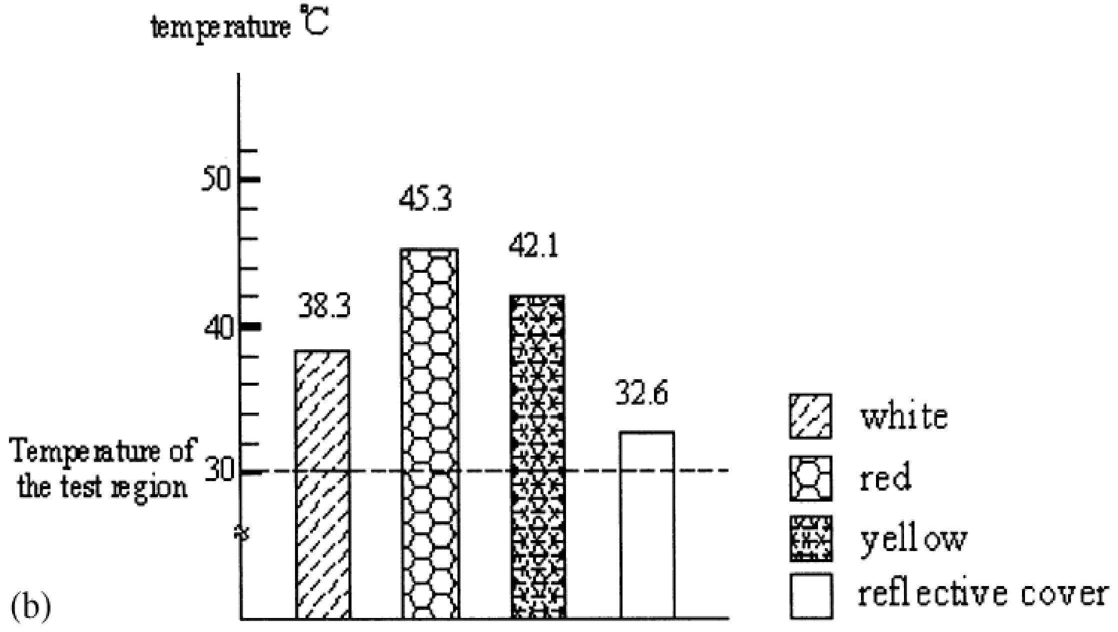



Personal Protection

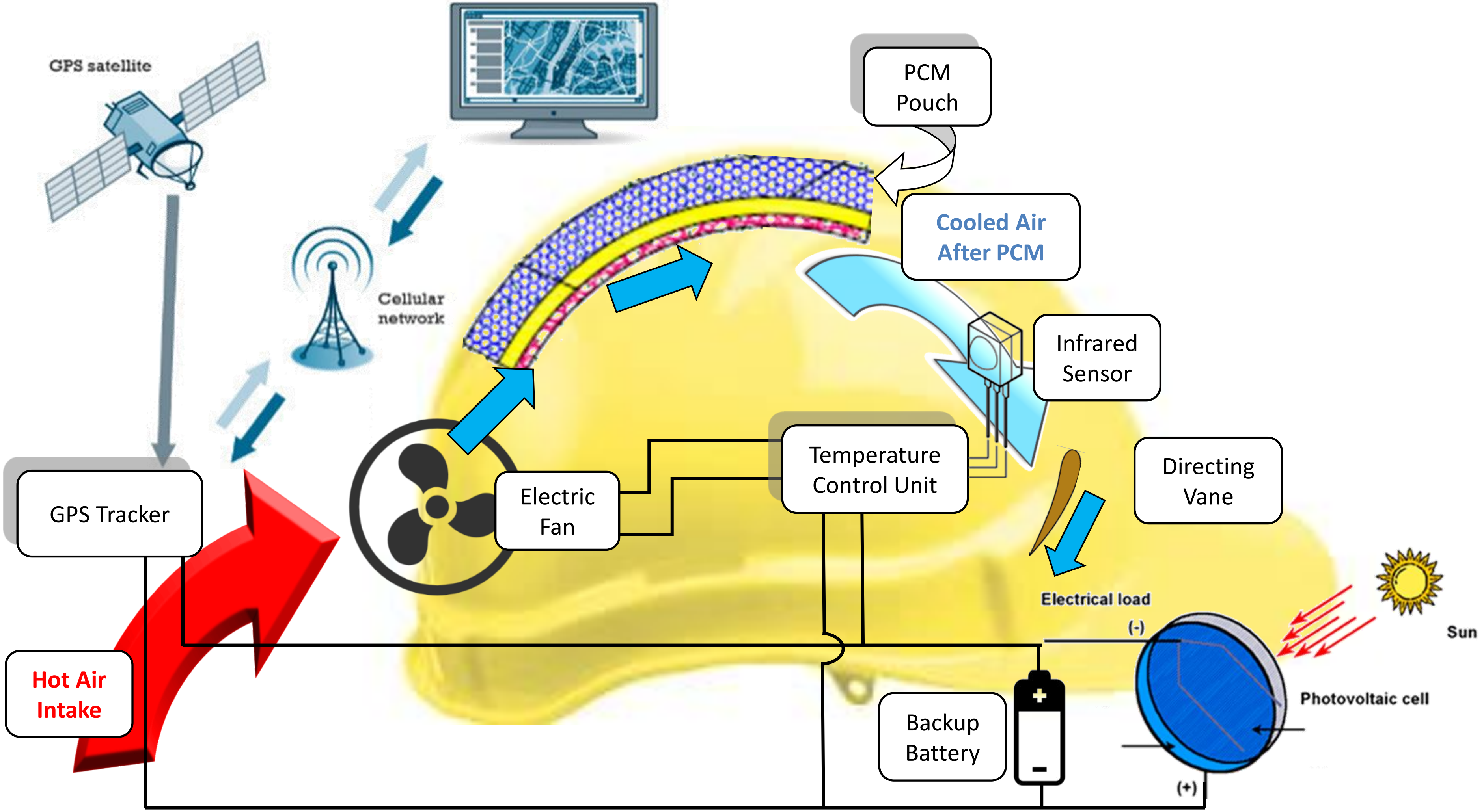


Workers Helmet

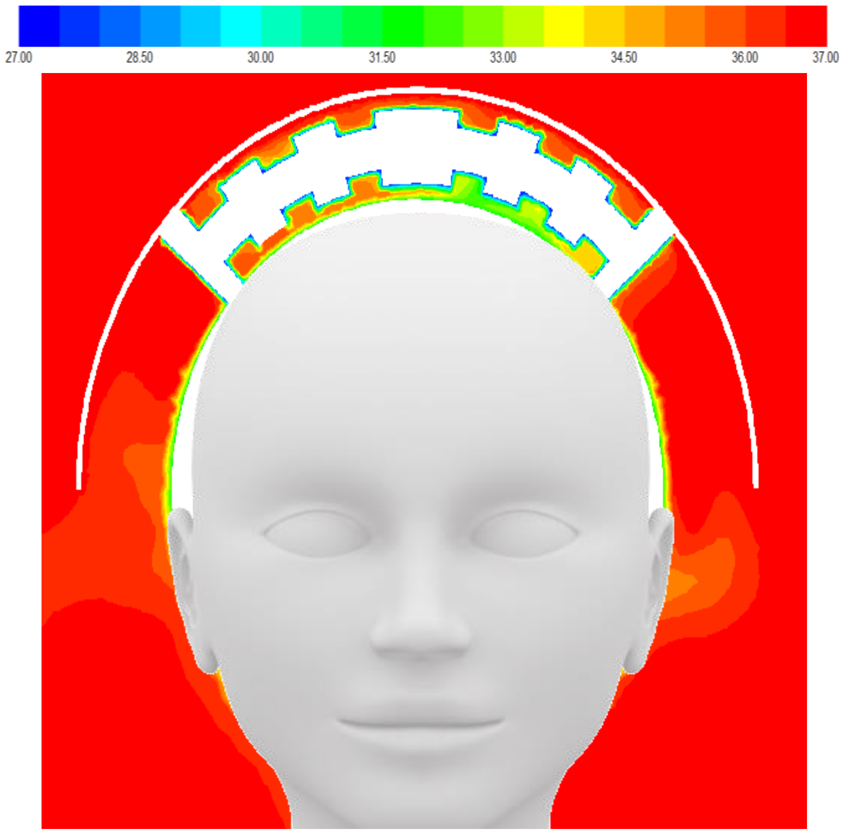
Establishing the thermal effect of different Workers Helmet Colors.
Passively and for the same solar exposure,
White has the best thermal passive performance
Yellow has a difference of 3.8 ^{o}C
Red has a difference of 7^{o}C



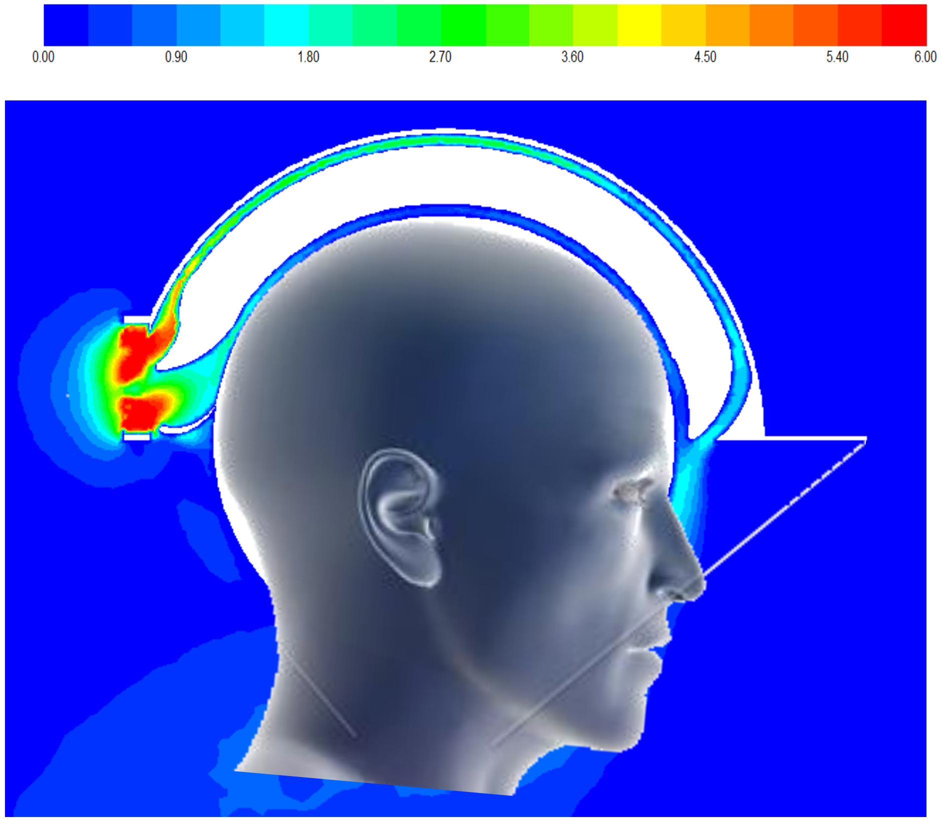
Q22 Smart Helmet



Q22 Smart Helmet



Temperature distribution around worker's head



Fan effect on air velocity and distribution

Patented Technology

Organization
International Bureau

(43) International Publication Date
1 September 2016 (01.09.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/135529 A1

(51) International Patent Classification: *A42B 3/04* (2006.01)

(21) International Application Number: PCT/IB2015/051378

(22) International Filing Date: 24 February 2015 (24.02.2015)

(25) Filing Language: English

(26) Publication Language: English

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(74) Agents: CREASE, Devanand et al.; Keltie LLP, No.1 London Bridge, London SE1 9BA (GB).

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Published:

— *with international search report (Art. 21(3))*

(54) Title: PROTECTIVE HEADGEAR COMPRISING TEMPERATURE CONTROL APPARATUS

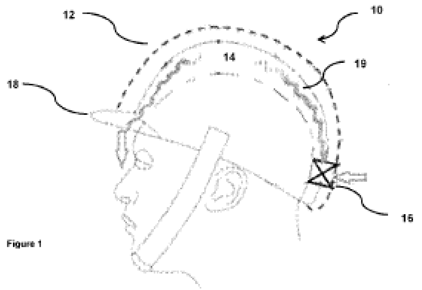


Figure 1

Made Available to the Academia and Researchers

Applied Thermal Engineering 111 (2017) 624–637

Contents lists available at ScienceDirect

Applied Thermal Engineering

journal homepage: www.elsevier.com/locate/apthermeng

ELSEVIER

Research Paper

The effect of forced convection and PCM on helmets' thermal performance in hot and arid environments

CrossMark

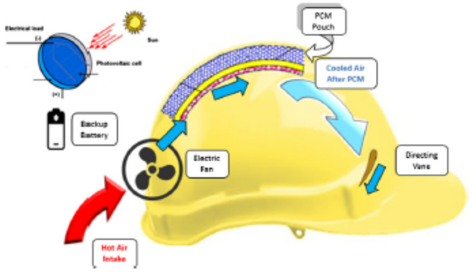
Saud Ghani *, Esmail Mohame Ali Ahmed ElBialy, Foteini Bakochristou, Seifelislam Mahmoud Ahmad Gamaledin, Mohammed Mohammed Rashwan

Qatar University, Mechanical and Industrial Engineering, Doha 2713, Qatar

HIGHLIGHTS

- The PCM embedded in the helmet proved to prolong the thermal comfort period.
- The heat generated from the head is the dominant factor that affects the melting time of the PCM.
- The incident wind speed proves to play an important role on the user's skin temperature and the sweat generation rate.

GRAPHICAL ABSTRACT



ARTICLE INFO

ABSTRACT

خوذ مكيفة تعمل بالطاقة الشمسية

كيف تعمل؟

طوّر باحثون من جامعة قطر بالتعاون مع اللجنة العليا للمشاريع والإرث وأسباير خوذة مكيفة مبتكرة تعمل بالطاقة الشمسية.

- تساعد على تخفيض الحرارة على عمال البناء العاملين في أجواء العمل الحارة بنسبة تصل إلى ١٠ درجات مئوية
- سيتم توزيع هذه الخوذ المكيفة في مواقع البناء التابعة للجنة العليا للمشاريع والإرث خلال فصل الصيف القادم.

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SOLAR-POWERED, COOLED HELMETS

How do they work?

Researchers at Qatar University, working with the Supreme Committee for Delivery & Legacy (SC) and Aspire, have developed an innovative solar-powered, cooled helmet.

- It can reduce temperature for construction workers in hot working environments by up to 10 degrees centigrade.
- The cooled helmets will be rolled out across SC construction sites for the coming summer.

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Q22 Smart Helmet

Helmet Side View

Helmet Front View

Q22 Smart Helmet

Phase Channing Material (PCM) Inner Pouch

Site Trials

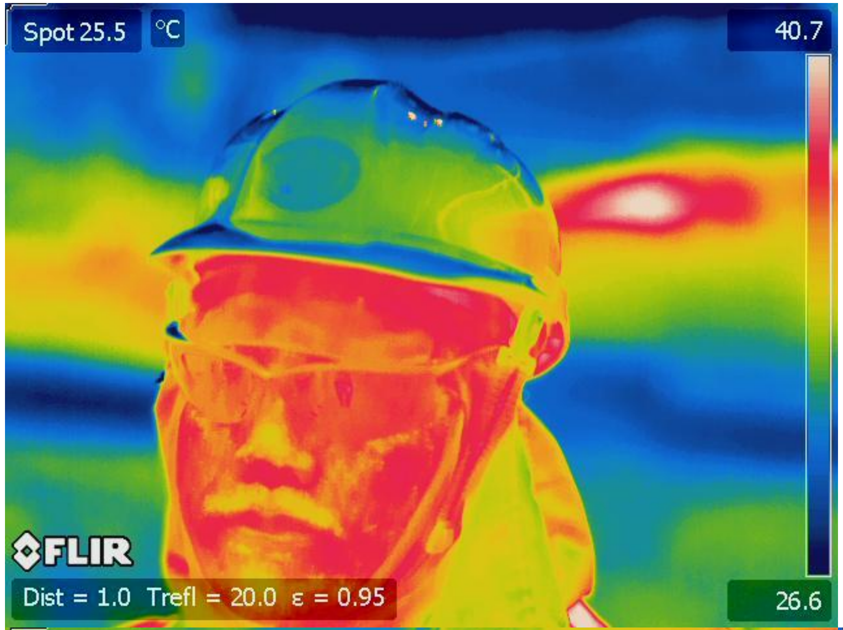
Khalifa Stadium Worker on a Passive Blue Helmet Thermal Imaging Result (19th Nov 2016)

Maximum Facial Hair Temperature of 34 °C

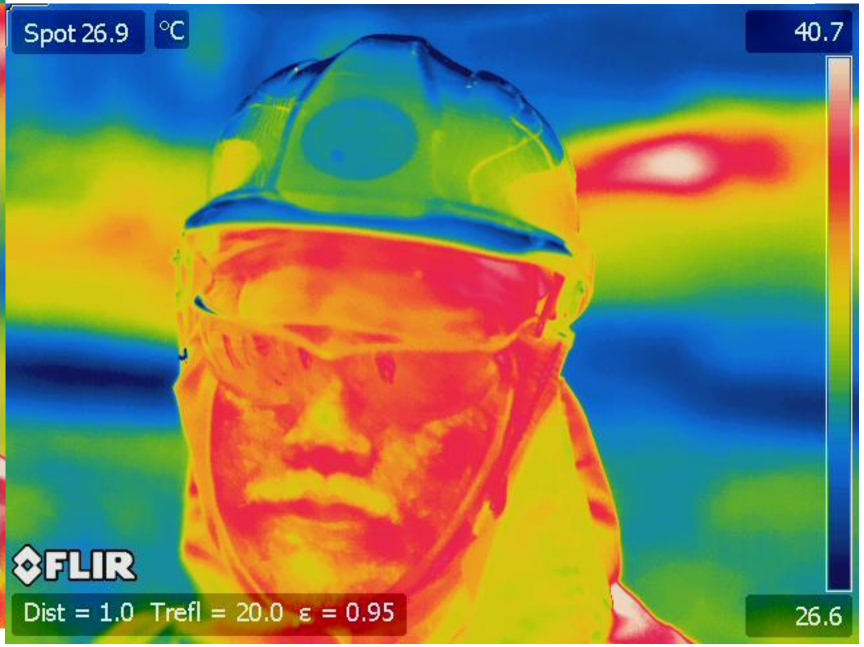
Maximum Helmet Temperature of 41 °C

Maximum Glasses Temperature of 41 °C

Maximum headcover Temperature of 41 °C


Spot 25.5
°C
40.7
FLIR
Dist = 1.0 Trefl = 20.0 ε = 0.95
26.6


Spot 24.2
°C
40.7
FLIR
Dist = 1.0 Trefl = 20.0 ε = 0.95
26.6


Spot 26.9
°C
40.7
FLIR
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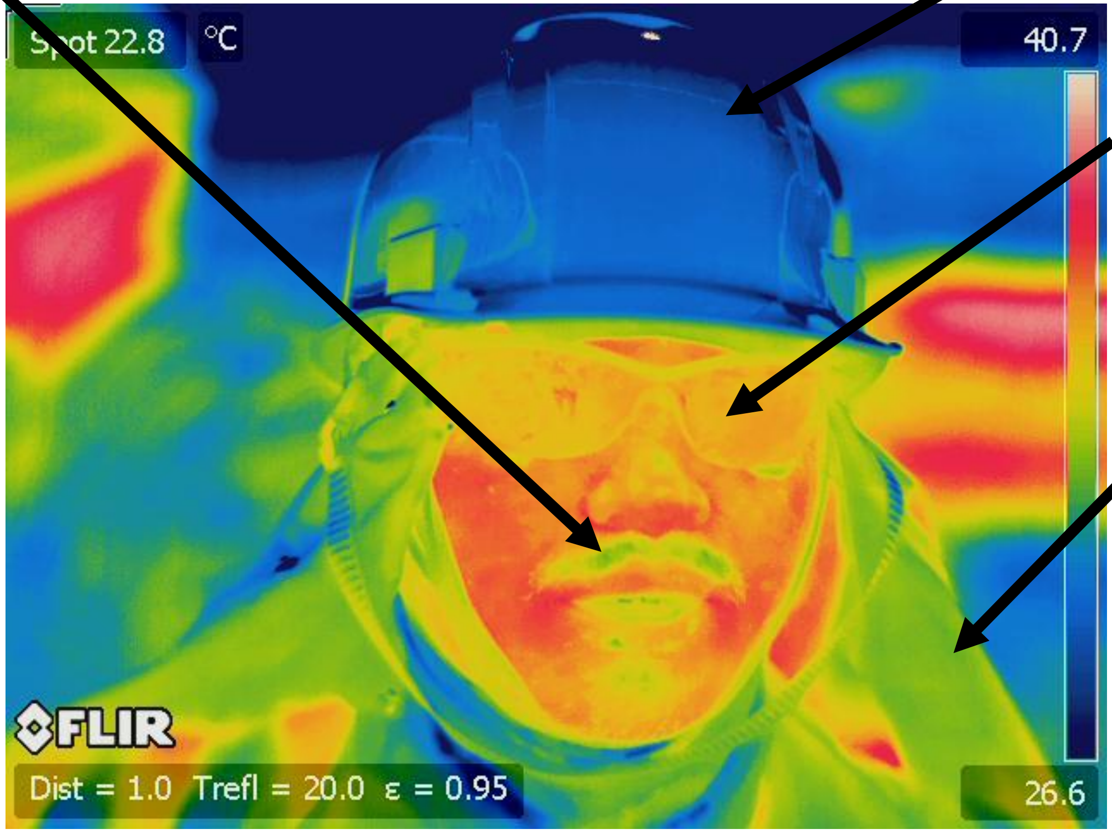
26.6

Khalifa Stadium Worker on the Solar Helmet Thermal Imaging Result (19th Nov 2016)

Maximum Facial Hair Temperature of 29 °C

Maximum Helmet Temperature of 28 °C

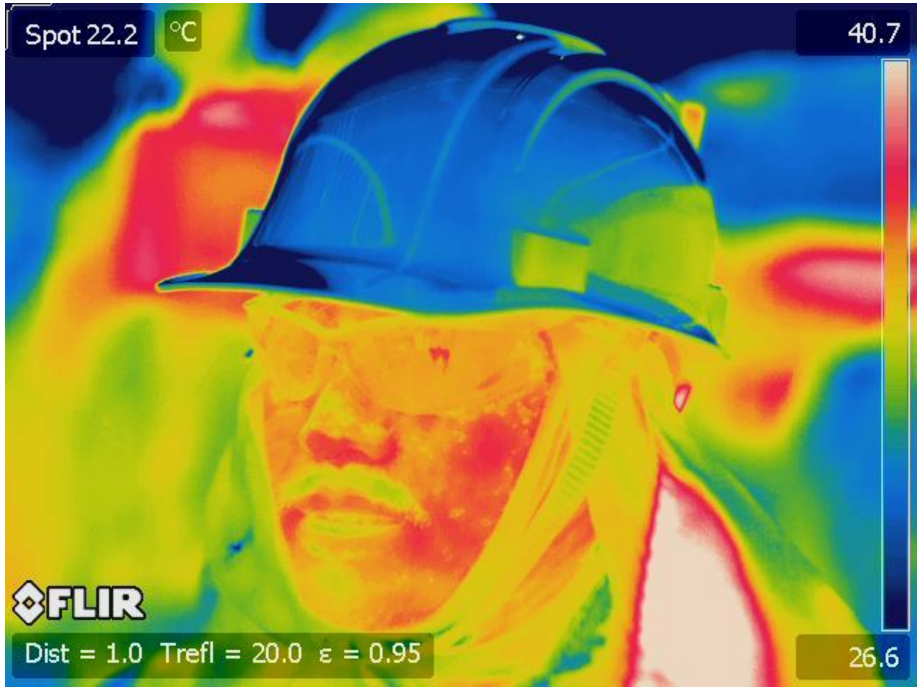


Maximum Glasses Temperature of 34 °C

Maximum headcover Temperature of 30 °C

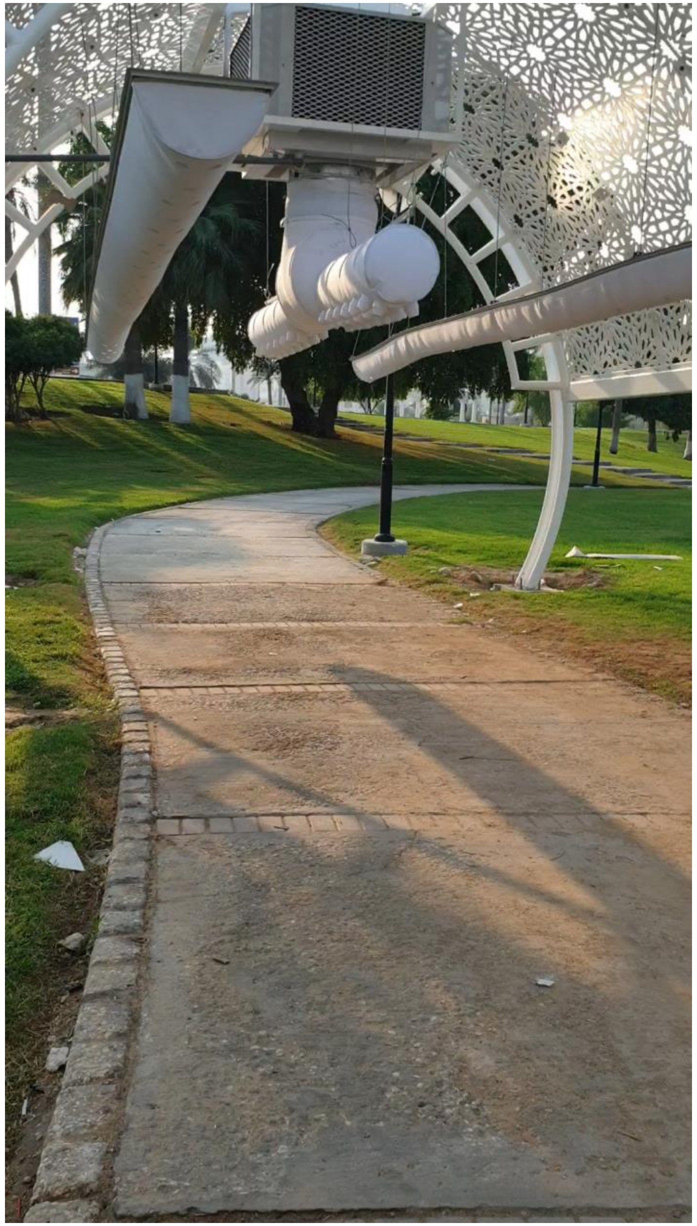

Spot 23.5 °C
40.7
FLIR
Dist = 1.0 Trefl = 20.0 ε = 0.95
26.6


Spot 22.8 °C
40.7
FLIR
Dist = 1.0 Trefl = 20.0 ε = 0.95
26.6


Spot 22.2 °C
40.7
FLIR
Dist = 1.0 Trefl = 20.0 ε = 0.95
26.6

Domestic, Services and Commercial Building Stock

INNClimat



Partners and Stockholders

وزارة البيئـــــــــة والتغيّـــــــــر المناخــــــــي
Ministry of Environment and Climate Change
State of Qatar • دولـــة قطـــر

وزارة البلديـــــــــــــــــــــة
Ministry of Municipality
State of Qatar • دولـــة قطـــر

جامعة قطر
QATAR UNIVERSITY

مؤسسة حمد الطبية
Hamad Medical Corporation
HEALTH • EDUCATION • RESEARCH صحة - تعليم - بحوث

وزارة الصحة العامة
MINISTRY OF PUBLIC HEALTH
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INNO climat

UN environment

FIFA WORLD CUP Qatar2022

ASPIRE ZONE

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