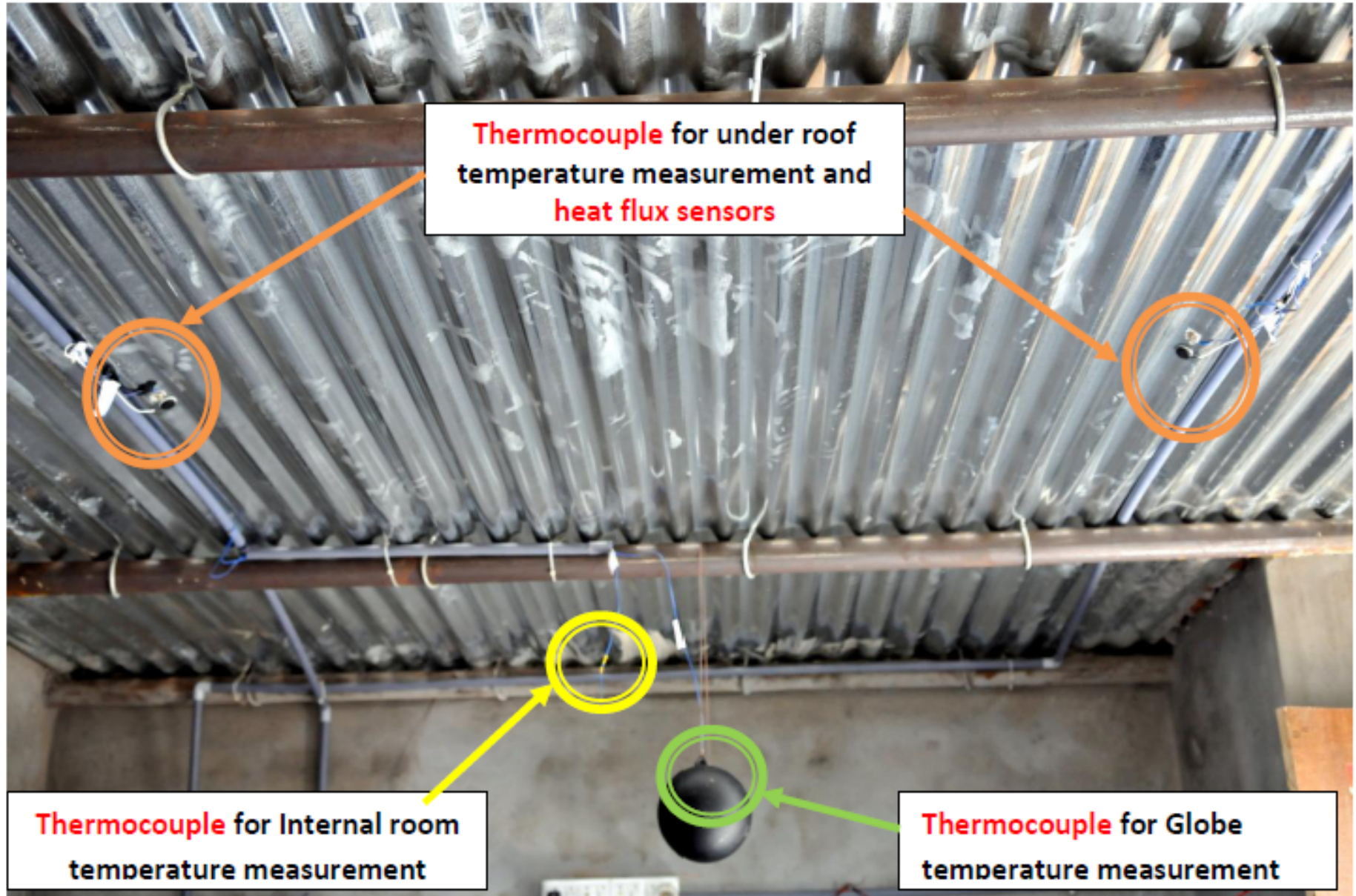


Study of Cool Roof on Low Income House Group

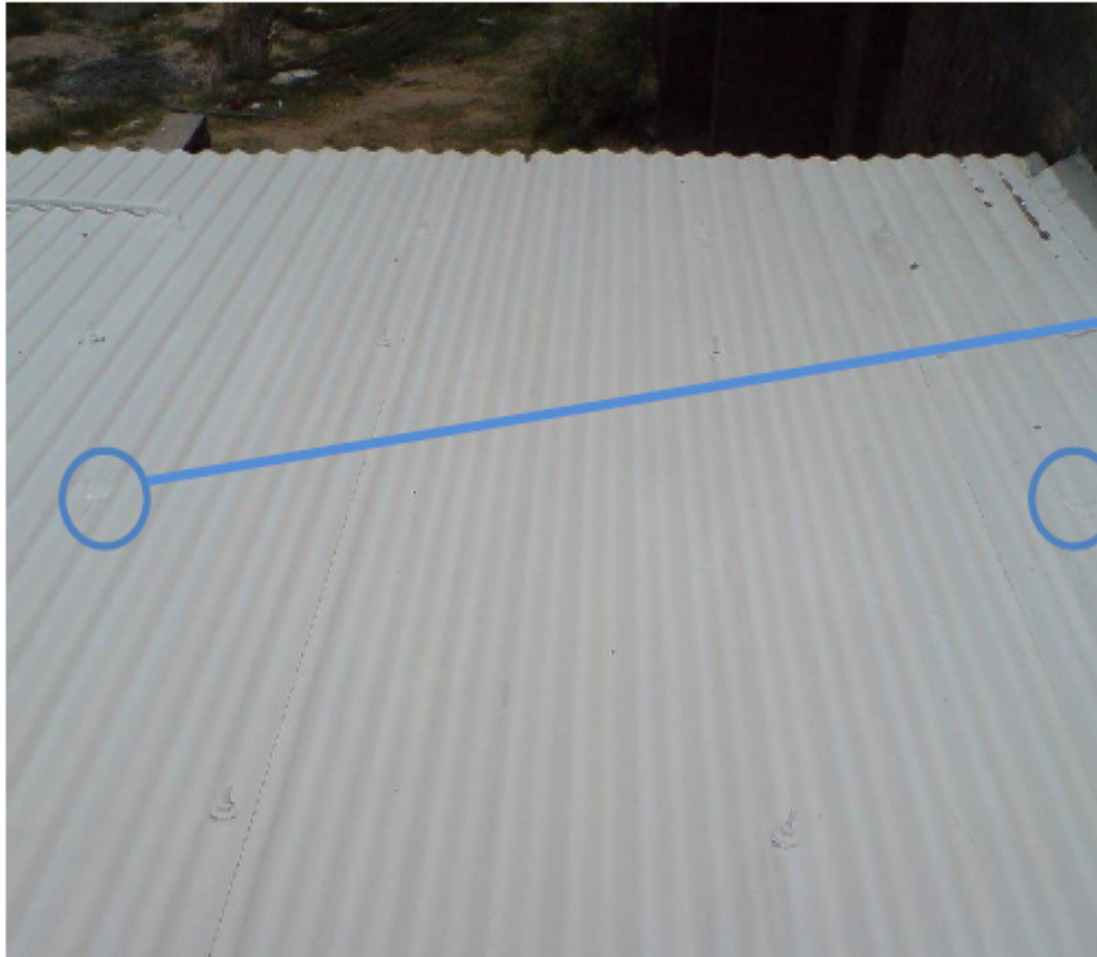
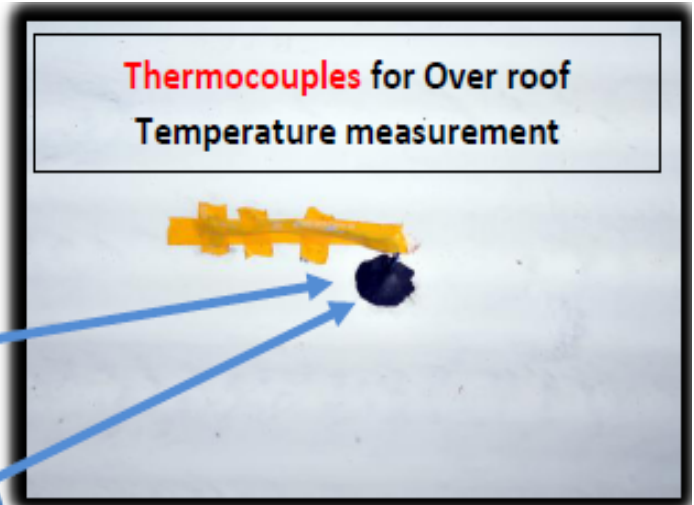
Sanand (Ahmedabad)



INSTRUMENTS AND SENSORS USED



INSTRUMENTS AND SENSORS USED

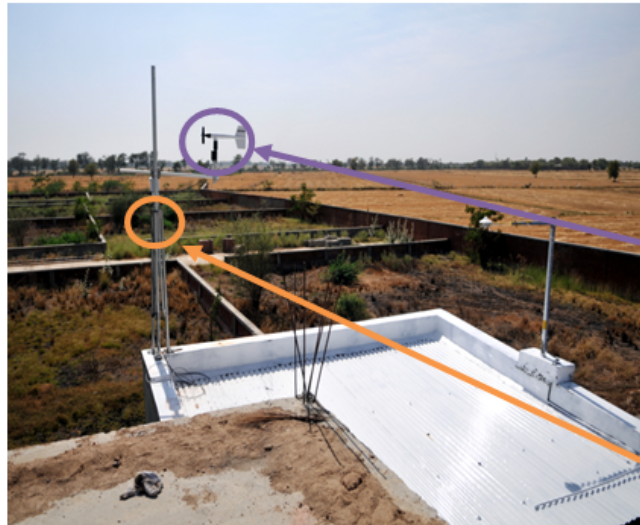


INSTRUMENTS AND SENSORS USED



Upward Facing Pyranometer
measures **Direct Incident** light

Downward Facing Pyranometer
measures **Reflected** light from the
white roof



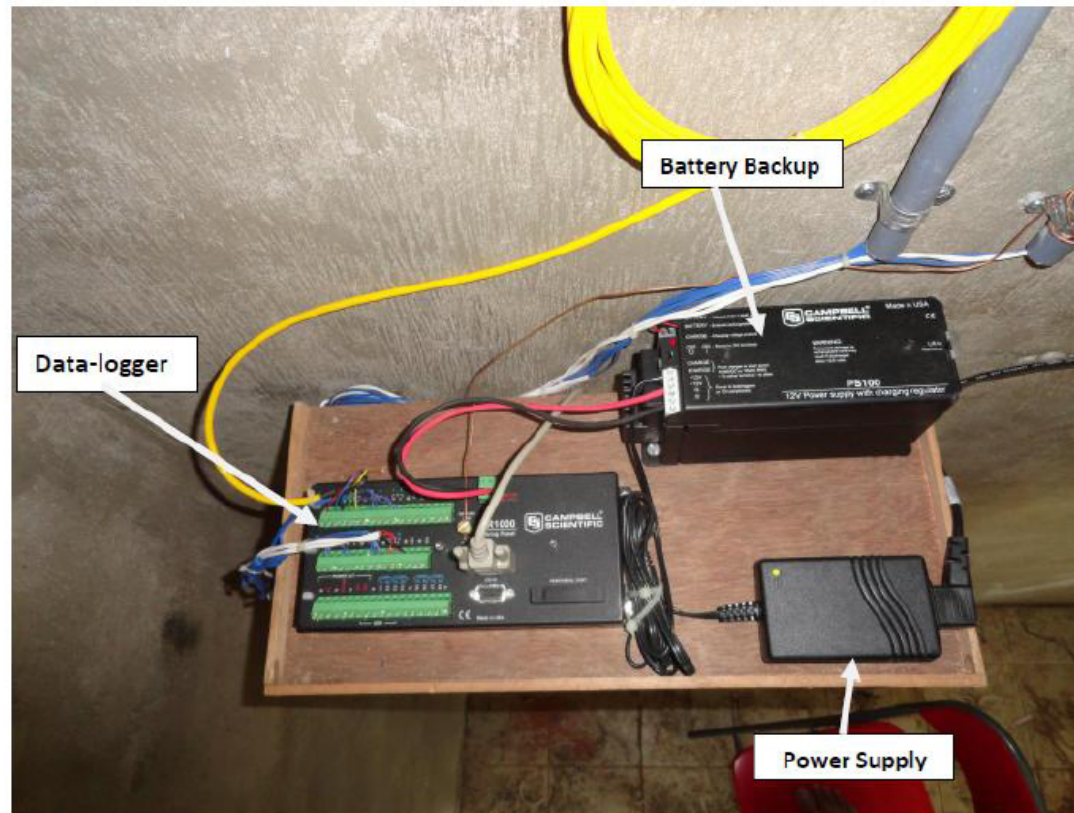
Anemometer measures Wind direction
and Wind Velocity



Hygrometer measures relative humidity



INSTRUMENTS AND SENSORS USED



TIMESTAMP	RECORD	BattV	PTemp_C	GLB_Surf	Out_TC_A	In_TC_A	Out_TC_B	In_TC_B	Amb_TC	Globe_TC	HF_A	HF_B
2012-06-02 12:50:00	0	12.99	37.29	37.7	58.82	58.56	59.91	54.06	37.82	37.63	18.62	16.57
2012-06-02 13:00:00	1	13	37.55	37.98	57.96	57.71	59.51	54.39	38.18	37.86	17.42	15.09
2012-06-02 13:10:00	2	13	37.79	38.29	57.73	57.5	58.45	54.41	38.52	38.14	15.89	14.43
2012-06-02 13:20:00	3	13	38.02	38.48	54.82	54.56	55.86	51.35	38.69	38.35	17.13	13.4
2012-06-02 13:30:00	4	13	38.22	38.54	57.87	57.68	58.86	53.73	38.81	38.48	15.93	15.37

OBSERVATIONS

28/06/2012



AVERAGE INCIDENT FLUX (6.30AM-7PM) : 568 W/m^2

MAXIMUM INCIDENT FLUX: 1033 W/m^2

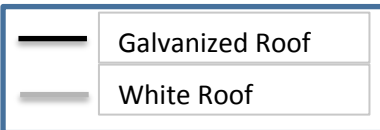
REFLECTIVITY OF PAINT: 52%

Average Ambient Temperature : 36.29°C

MAX: 42.6°C MIN: 24.7°C

Average Relative Humidity : 31%

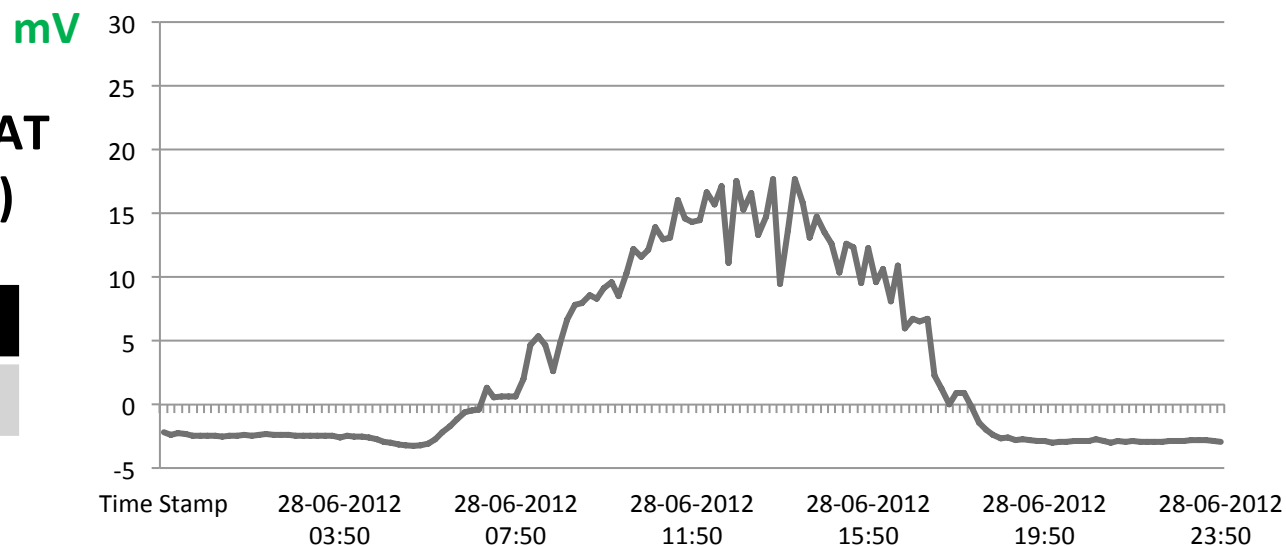
Average Wind Speed: 2.6 m/s



HEAT FLUX

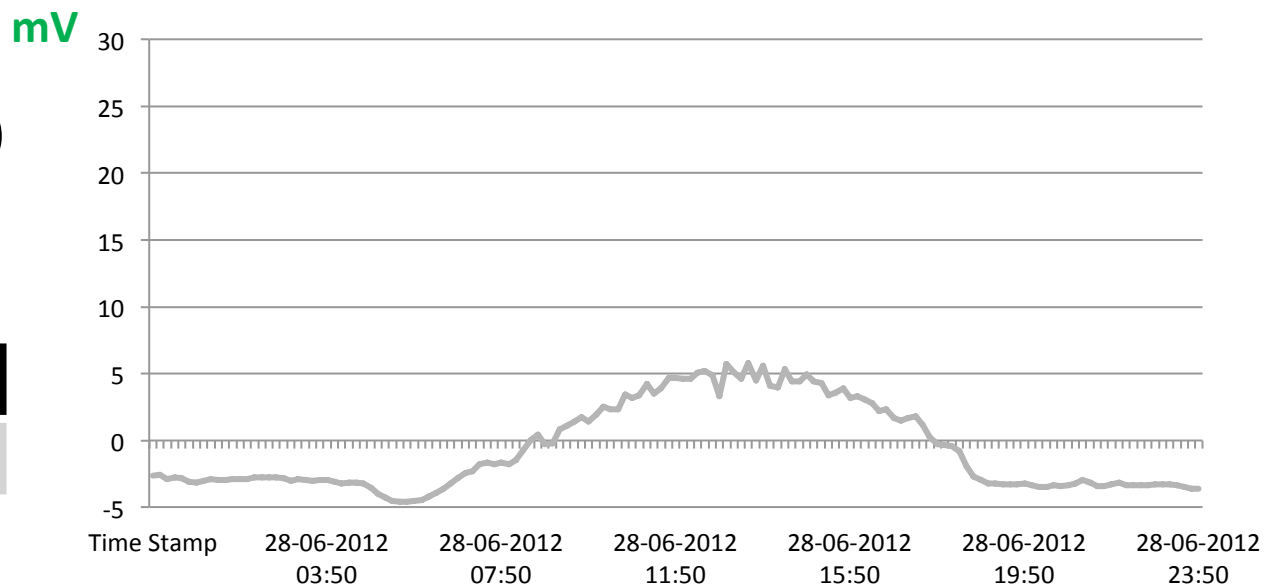
GALVANIZED ROOF HEAT FLUX READINGS (mV)

MAX	MIN
17.72 mV	-3.23 mV



WHITE ROOF HEAT FLUX READINGS (mV)

MAX	MIN
5.8 mV	-4.9 mV



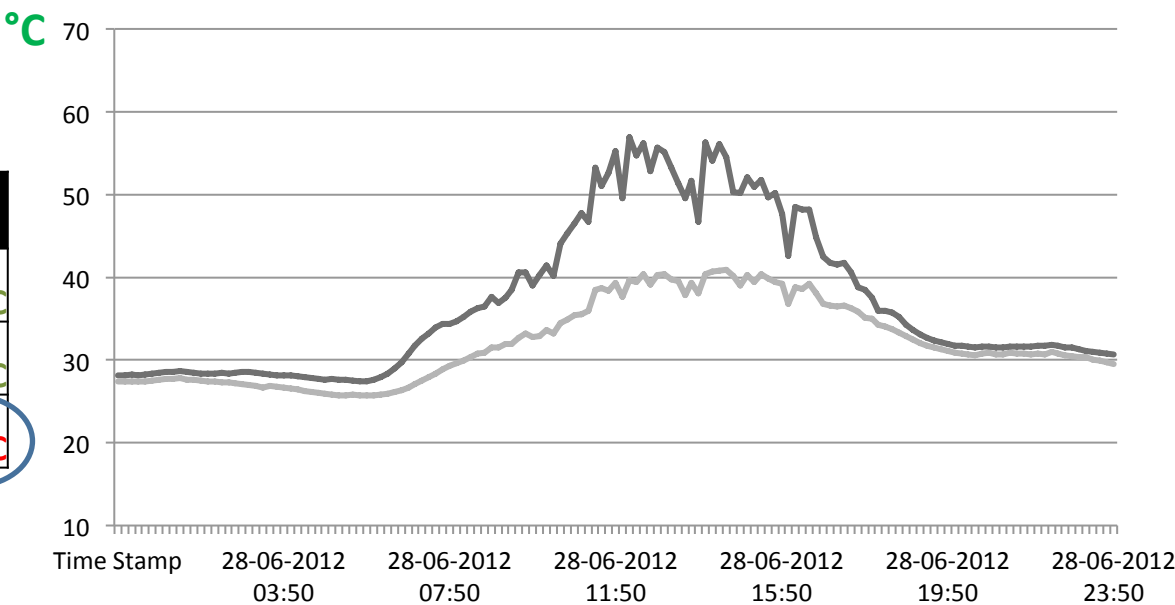

Galvanized Roof


White Roof

OVER ROOF TEMPERATURE

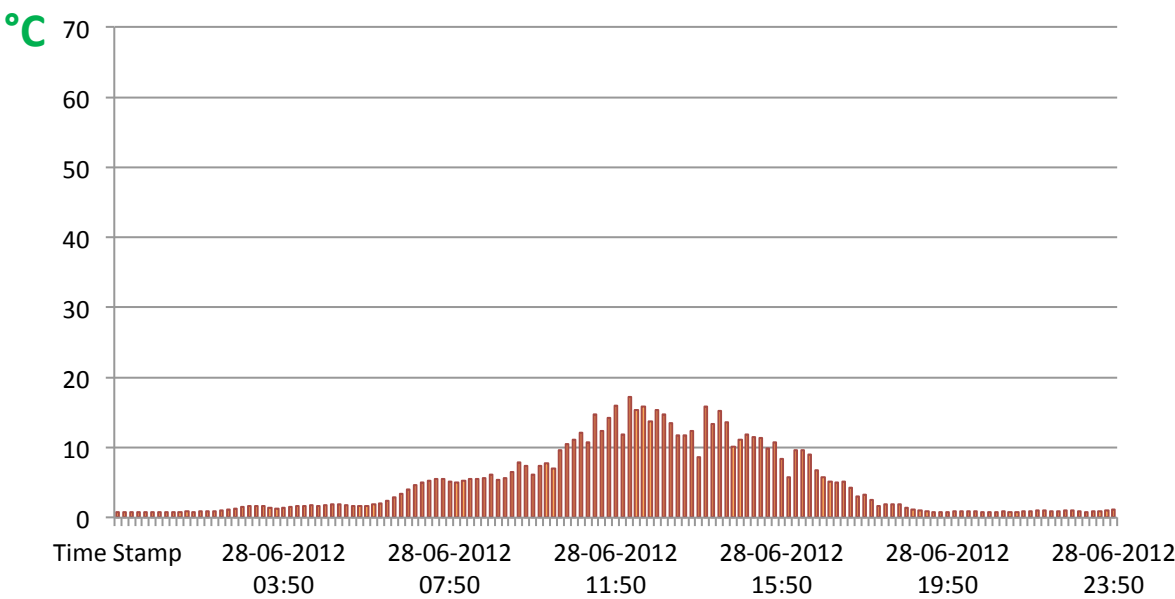
OVER ROOF TEMPERATURE

	GALV.	COOL	DIFF.
MAX	57°C	41°C	16°C
MIN	28°C	26°C	2°C
AVG	37°C	32°C	5°C



HOW MUCH WARMER IS GALVANIZED OVER ROOF COMPARED TO WHITE OVER ROOF(°C)?

MAX	MIN
18°C	0.8°C

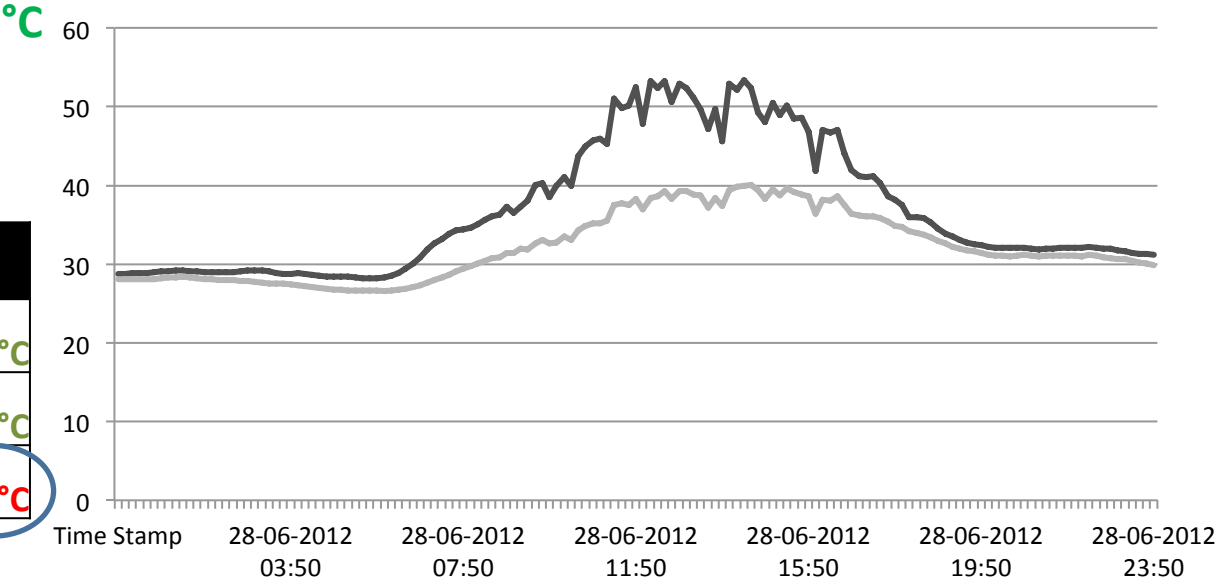


Galvanized Roof

White Roof

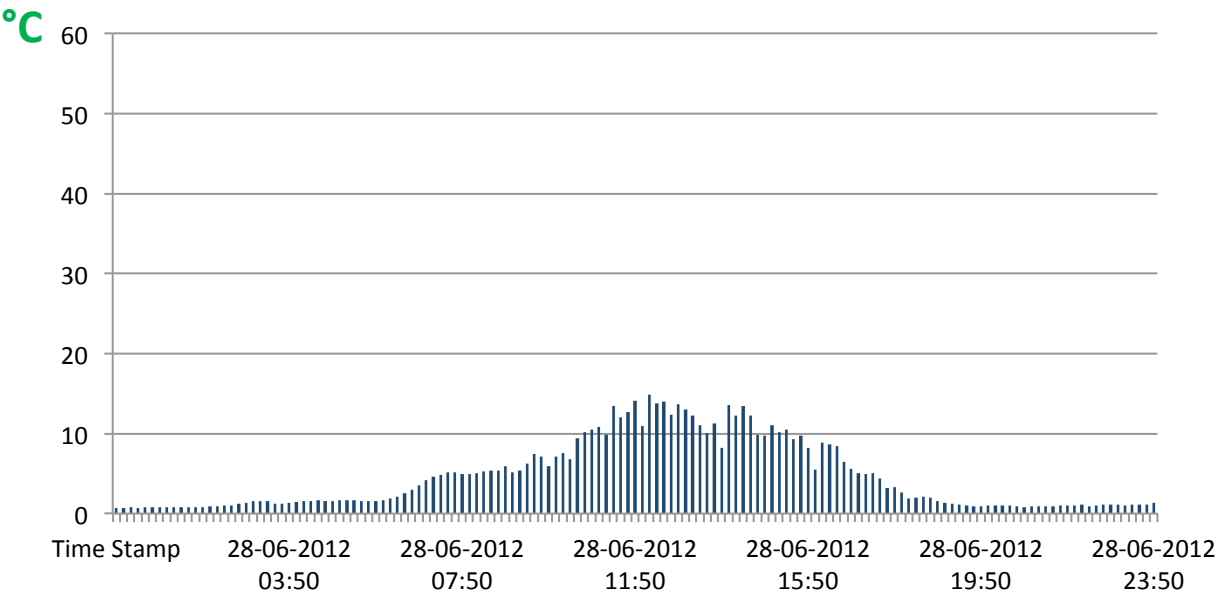
UNDER ROOF TEMPERATURE

UNDER ROOF TEMPERATURE



HOW MUCH WARMER IS GALVANIZED UNDER ROOF COMPARED TO WHITE OVER ROOF(°C)?

MAX	MIN
15°C	0.7°C

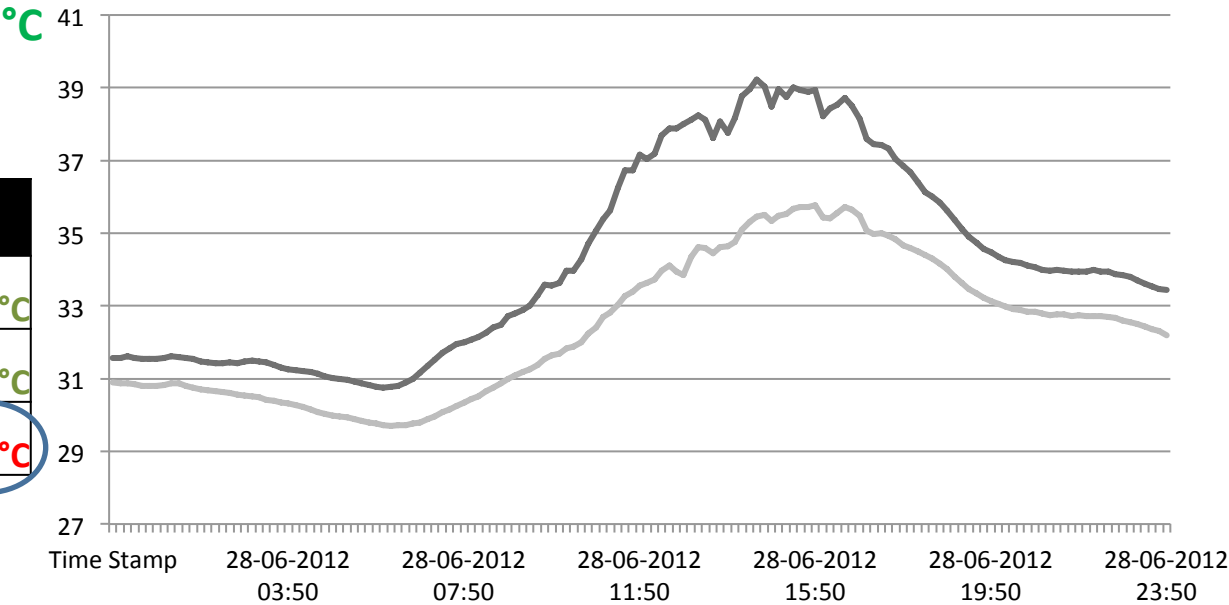


Galvanized Roof

White Roof

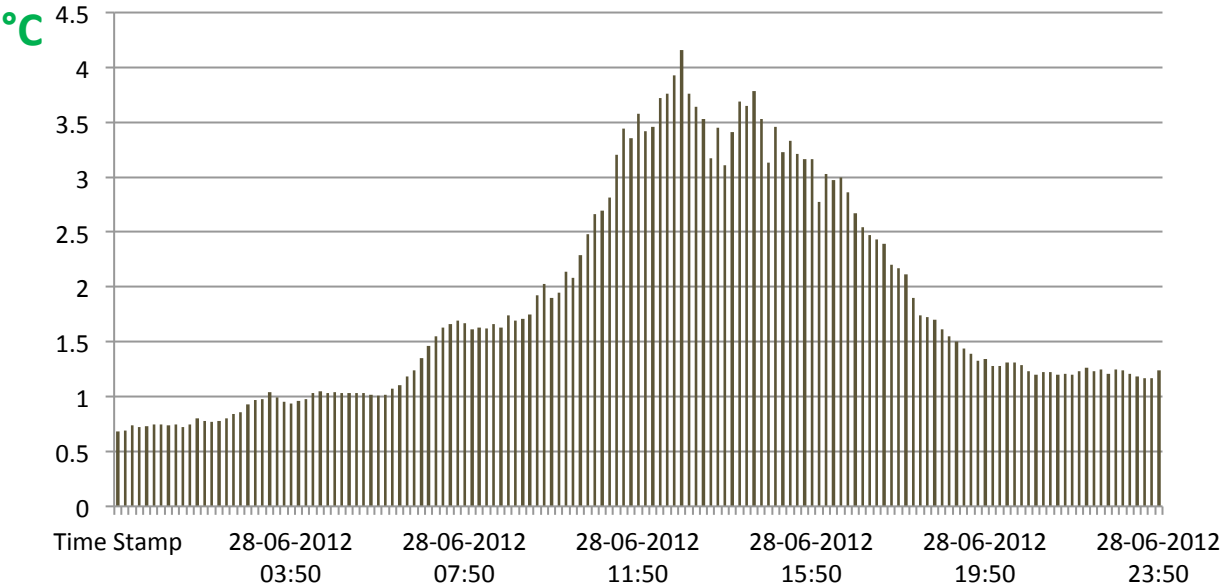
INTERNAL ROOM TEMPERATURE

INTERNAL ROOM TEMPERATURE



GALVANIZED – WHITE (INTERNAL ROOM TEMPERATURE)

MAX	MIN
4.2°C	0.7°C



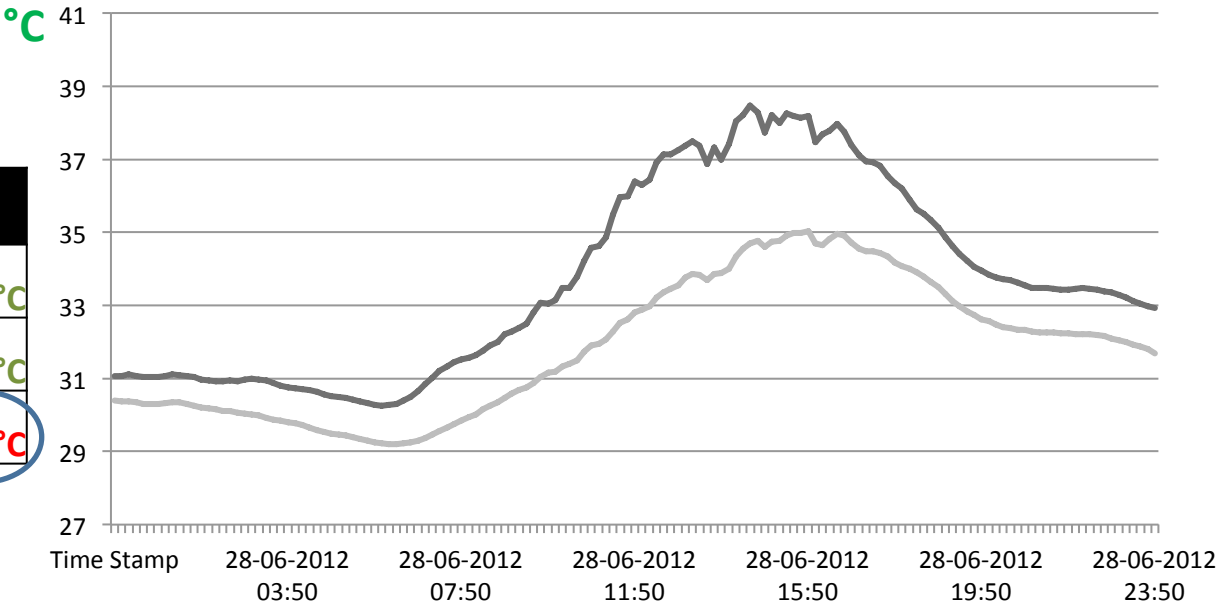
Galvanized Roof

White Roof

GLOBE SURFACE TEMPERATURE

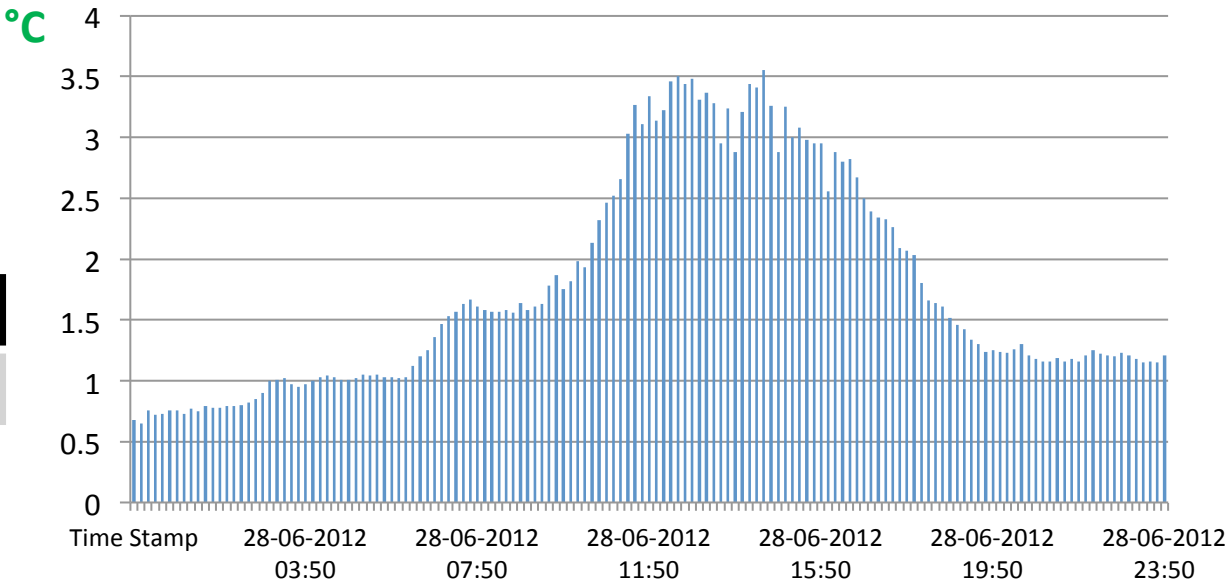
GLOBE SURFACE TEMPERATURE

	GALV.	COOL	DIFF.
MAX	38.5°C	35°C	3.5°C
MIN	30.3°C	29.2°C	1.1°C
AVG	34.3°C	31.2°C	3.1°C



GALVANIZED – WHITE (GLOBE TEMPERATURE)

MAX	MIN
3.55°C	0.7°C

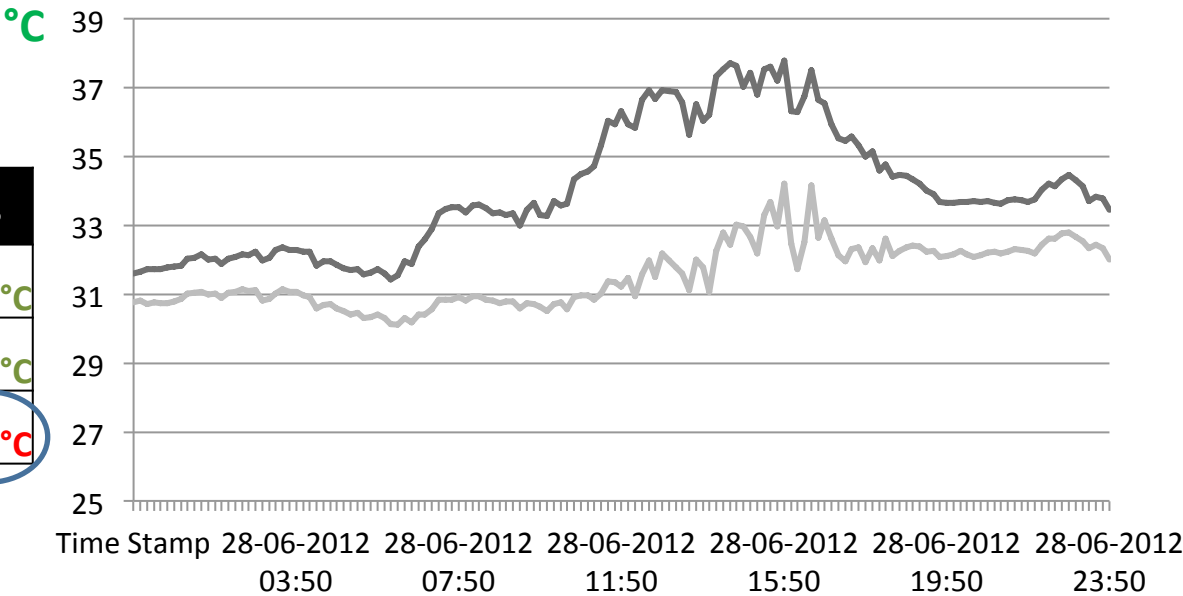


	Galvanized Roof
	White Roof

MEAN RADIANT TEMPERATURE

MEAN RADIANT TEMPERATURE

	GALV.	COOL	DIFF.
MAX	37.8°C	34.2°C	3.6°C
MIN	31.6°C	30.3°C	1.3°C
AVG	35.4°C	31.5°C	3.9°C

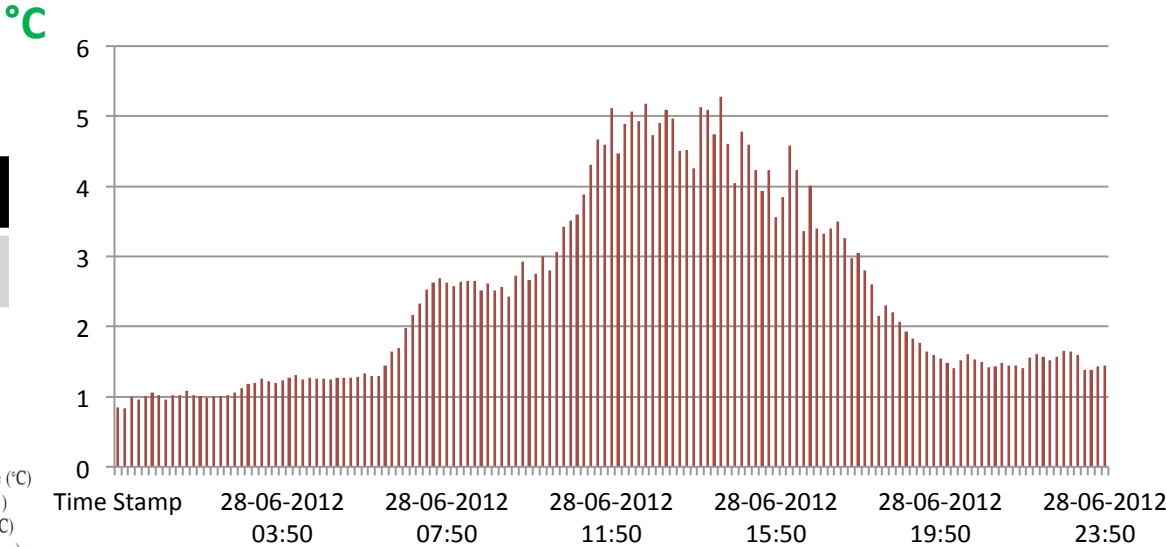


GALVANIZED – WHITE (MRT)

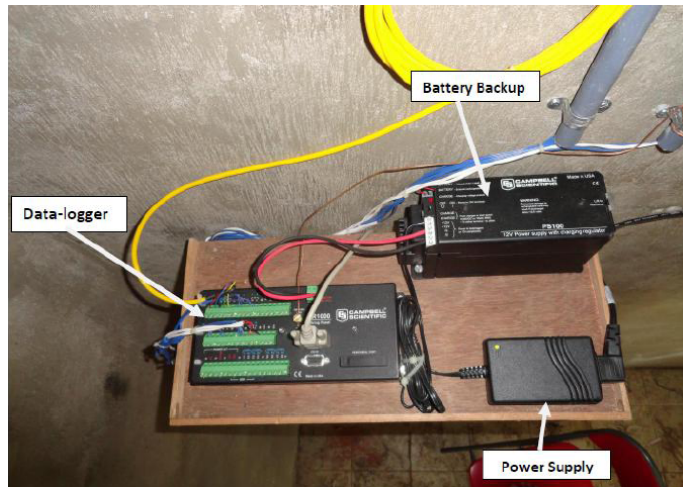
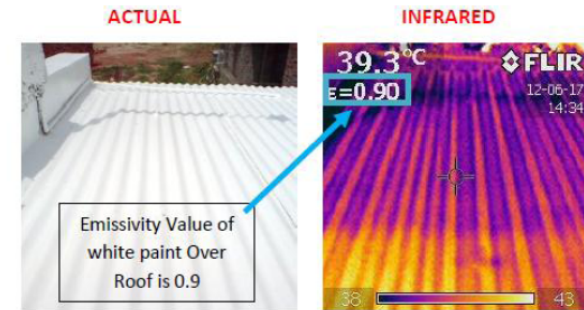
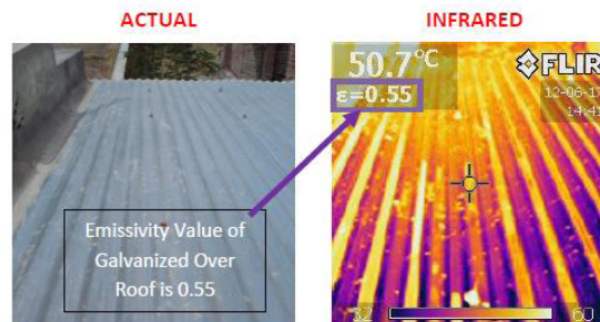
MAX	MIN
5.2°C	0.8°C

$$T_{\text{mrt}} = \left[(T_g + 273.15)^4 + \frac{1.1 \times 10^8 V_a^{0.6}}{\varepsilon D^{0.4}} \times (T_g - T_a) \right]^{1/4} - 273.15$$

T_g = the globe temperature (°C)
 V_a = the air velocity (ms⁻¹)
 T_a = the air temperature (°C)
 D = the globe diameter (mm)
 ε = the globe emissivity



COMPARISON BETWEEN DATA FROM DATALOGGER AND INFRARED CAMERA



Environmental parameters

17/6/2012 (2.30 PM-2.50 PM)

TIMESTAMP	RECORD	PTemp_C_Avg	WS_ms_Avg	WindDir	AirTC_Avg	RH
2012-05-17 14:30:00	5036	35.09	4.309	234	41.26	15.39
2012-05-17 14:40:00	5037	35.24	4.511	287.5	41.05	15.63
2012-05-17 14:50:00	5038	35.41	4.795	299.2	41.55	15.19

Average Ambient Temperature : 41.29 °C

Average Relative Humidity : 15.4%

Average Wind Speed: 4.54 m/s

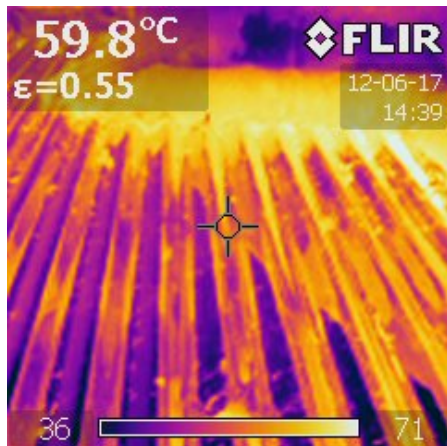
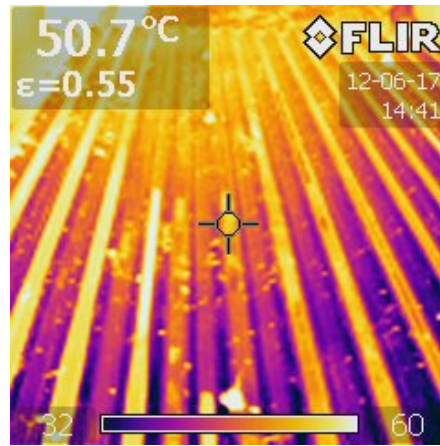
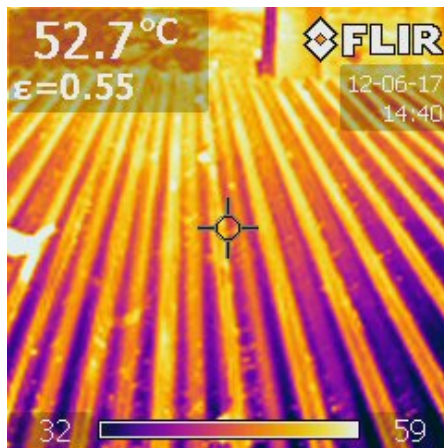
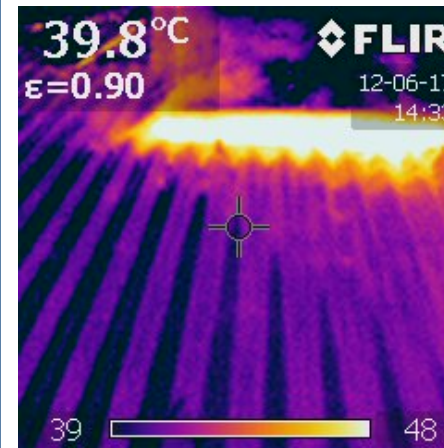
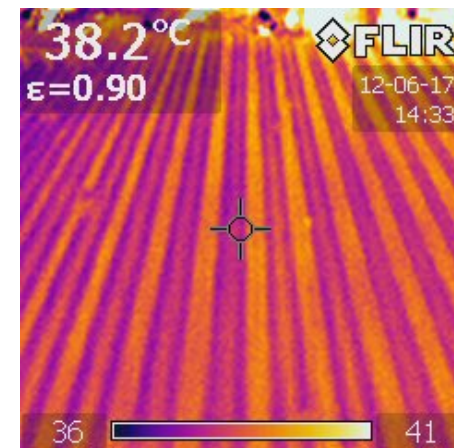
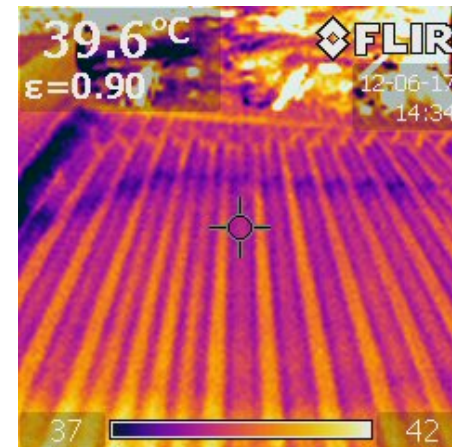
Wind Direction: 274 Degrees i.e. North West

Over Roof Temperature

17/6/2012 (2.30 PM-2.50 PM)

Roof without Paint

Roof with Paint



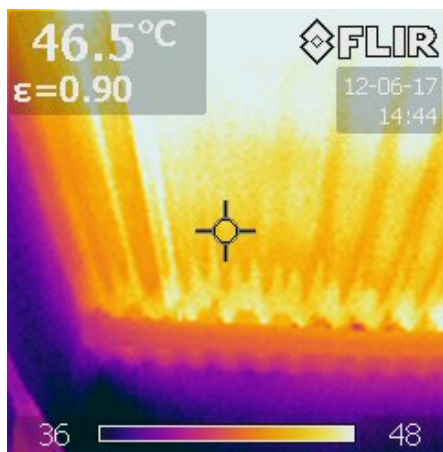
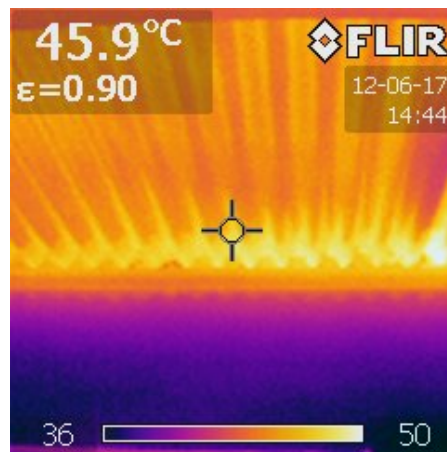
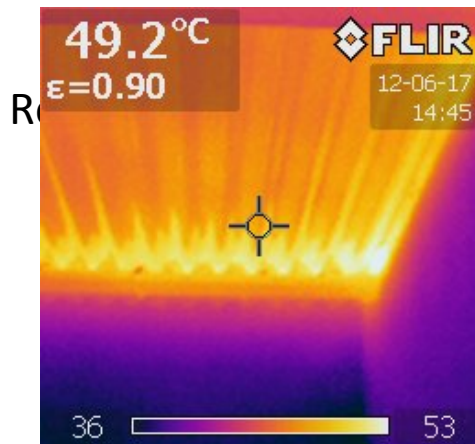
Min. Temp Difference
Is -4°C

Max. Temp Difference
is 20°C

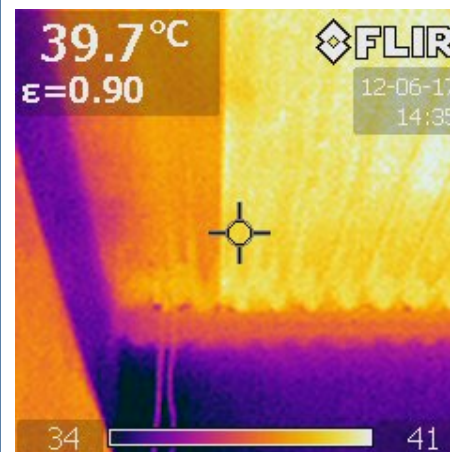
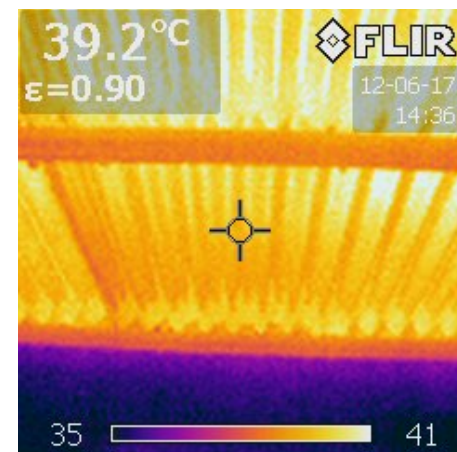
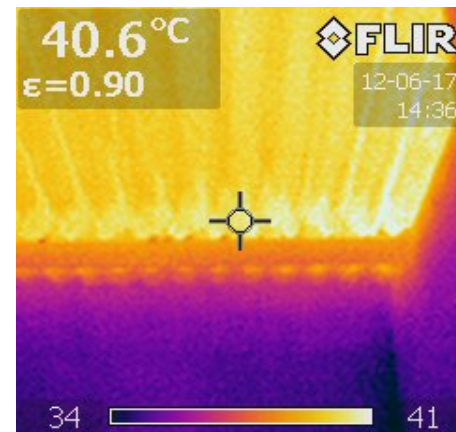
Under Roof Temperature

17/6/2012 (2.30 PM-2.50 PM)

Roof without Paint



Roof with Paint



Roof with Paint

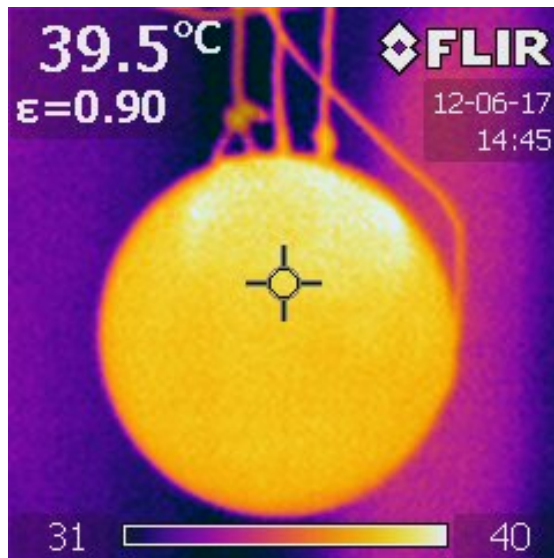
Min. Temp Difference
is 1.8°C

Max. Temp Difference
is 9.4°C

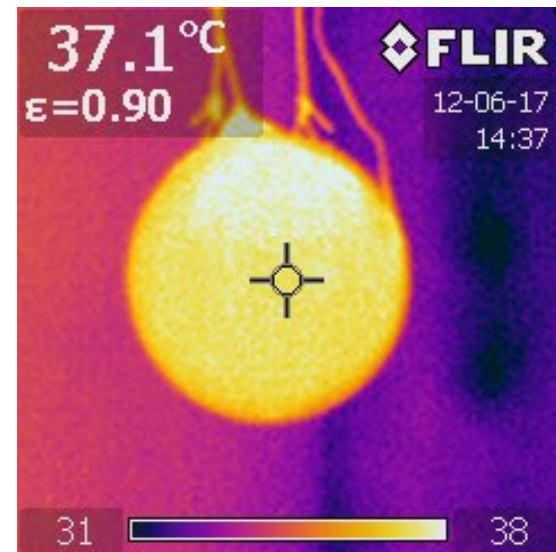
Globe Temperature

17/6/2012 (2.30 PM-2.45 PM)

Roof without Paint



Roof with Paint



- Globe of white roof is cooler by 2.4°C compared to globe of galvanized roof.
- The Globe of white roof room is cooler than external ambient temperature by 4.2 °C

Min. Temp Difference
is 0°C

Max. Temp Difference
is 2°C

Comparison of Readings from Data logger & Infrared Camera (17/6/2012)

TIMESTAMP	RECORD	BattV	PTemp_C	GLB_Surf	Out_TC_A	In_TC_A	Out_TC_B	In_TC_B	Amb_TC	Globe_TC	HF_A	HF_B
2012-06-17 14:30:00	2170	12.77	36.53	36.82	51.42	51.26	51.94	46.68	37.18	36.78	11.43	7.885
2012-06-17 14:40:00	2171	12.77	36.79	37.08	51.18	51.05	51.96	46.91	37.48	37	10.72	7.245
2012-06-17 14:50:00	2172	12.77	36.98	37.79	46.55	46.55	47.63	44.46	37.18	36.61	5.274	3.696

Galvanized Roof
Globe Surface Temp.
37.43°C
OBSERVED: 39.5°C

Galvanized Roof
Over Roof Temperature
50.2°C
OBSERVED: 54.4°C

White Roof
Over Roof Temperature
38.3°C
OBSERVED: 39.2°C

Galvanized Roof
Under Roof Temperature
47.82°C
OBSERVED: 47.2 °C

White Roof
Under Roof Temperature
37.4°C
OBSERVED: 39.6°C

White Roof
Globe Surface Temp.
35.21°C
OBSERVED: 37.1°C

TIMESTAMP	RECORD	BattV	PTemp_C	SlrW_U_Avg	SlrJ_U_Tot	SlrKW_D	SlrJ_D	Out_TC_A	In_TC_A	Out_TC_B	In_TC_B	Amb_TC	Globe_TC	HF_A	HF_B	GLB_Surf
2012-06-17 14:30:00	2165	12.75	34.94	794.9	39.74411	409.9	20.4953	38.45	38.32	38.63	36.77	35.45	35.34	5.559	2.598	35.36
2012-06-17 14:40:00	2166	12.75	35.07	781.5	39.07532	401.6	20.08192	38.5	38.42	38.7	36.85	35.71	35.52	5.425	2.558	35.58
2012-06-17 14:50:00	2167	12.75	35.14	551.1	27.55693	278.4	13.9177	37.68	37.5	37.85	36.51	35.33	35.38	2.759	1.511	35.39

COMPARISION

17/6/2012 (2.30 PM-2.50 PM)

	THERMOCOUPLES		INFRARED CAMERA	
	GALVANIZED ROOF	WHITE ROOF	GALVANIZED ROOF	WHITE ROOF
Over Roof Temp. °C	50.2	38.3	54.4	39.2
Under Roof Temp. °C	47.82	37.4	47.2	39.6
Globe Temp. °C	37.43	35.31	39.5	37.1
Globe of white roof as compared to galvanized roof is cooler by	2.1°C		2.4°C	

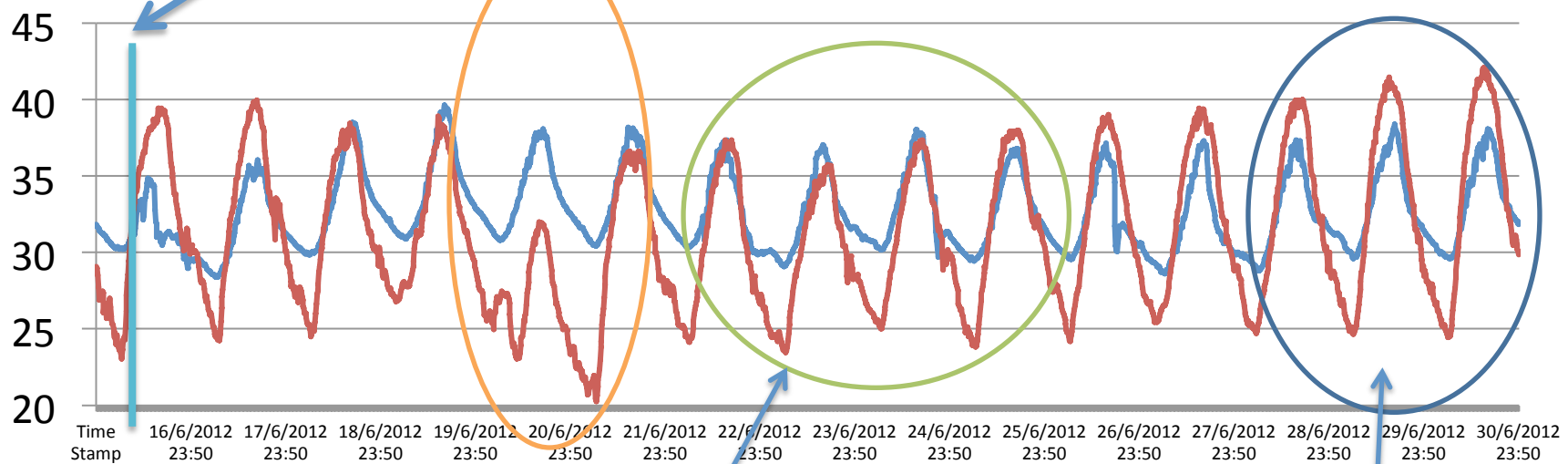
— OUTSIDE AMBIENT
— WHITE ROOF INTERNAL ROOM TEMP



Under Roof Painted With Grey Color

Maximum Direct Incident Flux : 978 W/m^2
WIND Speed : 2.7 m/s (AVG) 4.8 m/s (MAX)
Relative Humidity : 71% (AVG)
Ambient Temp.: MAX: 32°C MIN: 19°C

During this period, maximum humidity was observed. With humidity reaching its peaks at 90% and with average of 71% during the period, it is observed that white coated internal room temperature was 37°C where as average outside ambient temperature dropped to 28°C . The white coated room stayed cooler than Galvanized room by $1\text{--}3^\circ\text{C}$.



Maximum Direct Incident Flux : 978 W/m^2
WIND Speed : 2.3 m/s (AVG) 2.34m/s (MAX)
Relative Humidity : 42% (AVG)
Ambient Temp.: MAX: 38°C MIN: 24°C

Outside Ambient temp remained between 36°C and 37°C . White Roof Internal Temperature remained equal to outside ambient temperature. Even White coated room stayed cooler than the Galvanized room by $1\text{--}2^\circ\text{C}$.

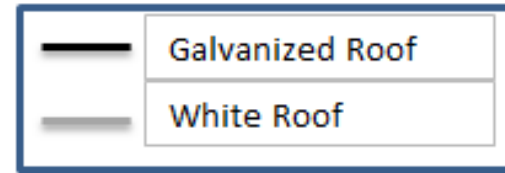
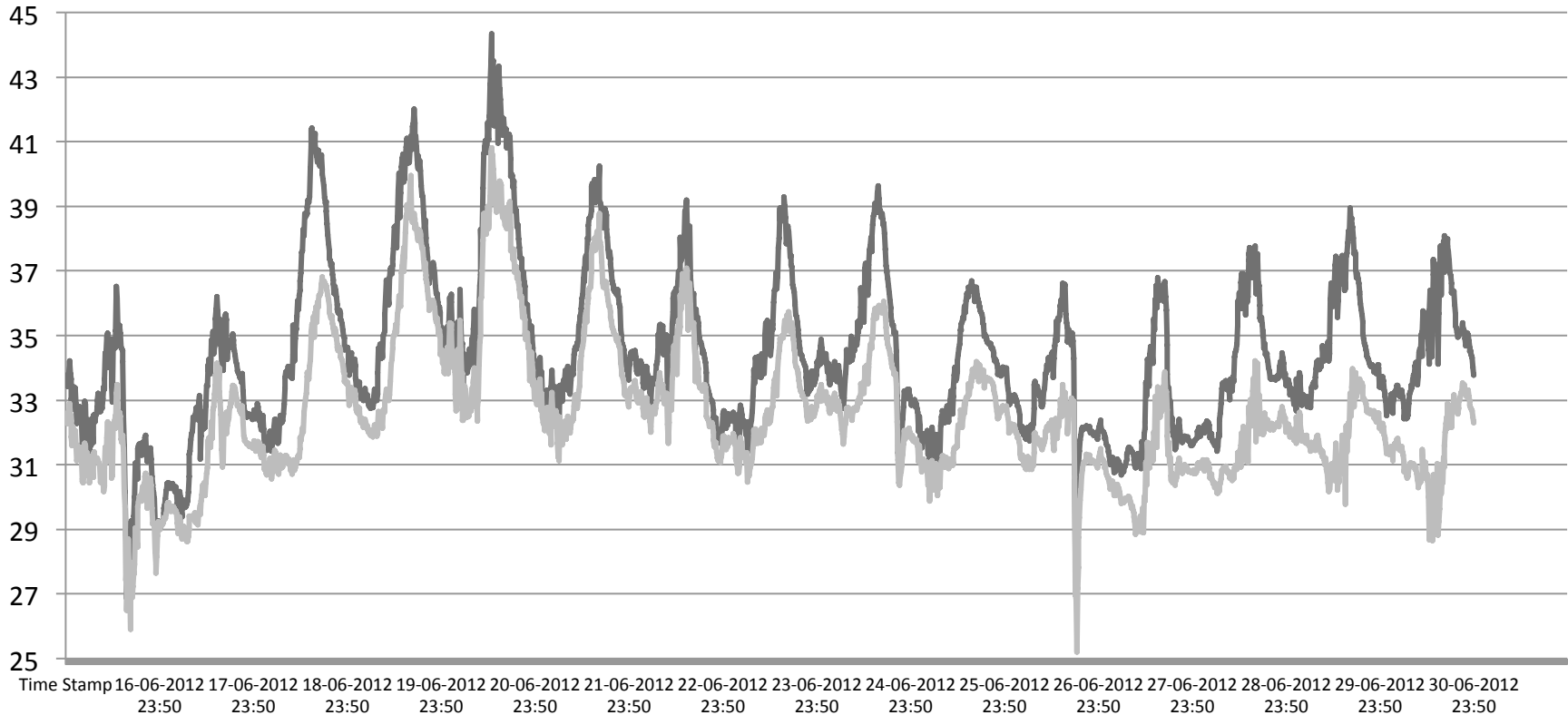


Maximum Direct Incident Flux : 1063 W/m^2

WIND Speed : 3.1 m/s (AVG) 6.5m/s (MAX)
Relative Humidity : 31% (AVG)
Ambient Temp.: MAX: 42°C MIN: 26°C

Outside Ambient temp rose from 39°C to 42°C . But Still White coated roof is cooler with peak temperature of 36°C . Even White coated room stayed cooler than the Galvanized room by $4\text{--}7^\circ\text{C}$ during Day time

Mean Radiant temperature Differences (°C)



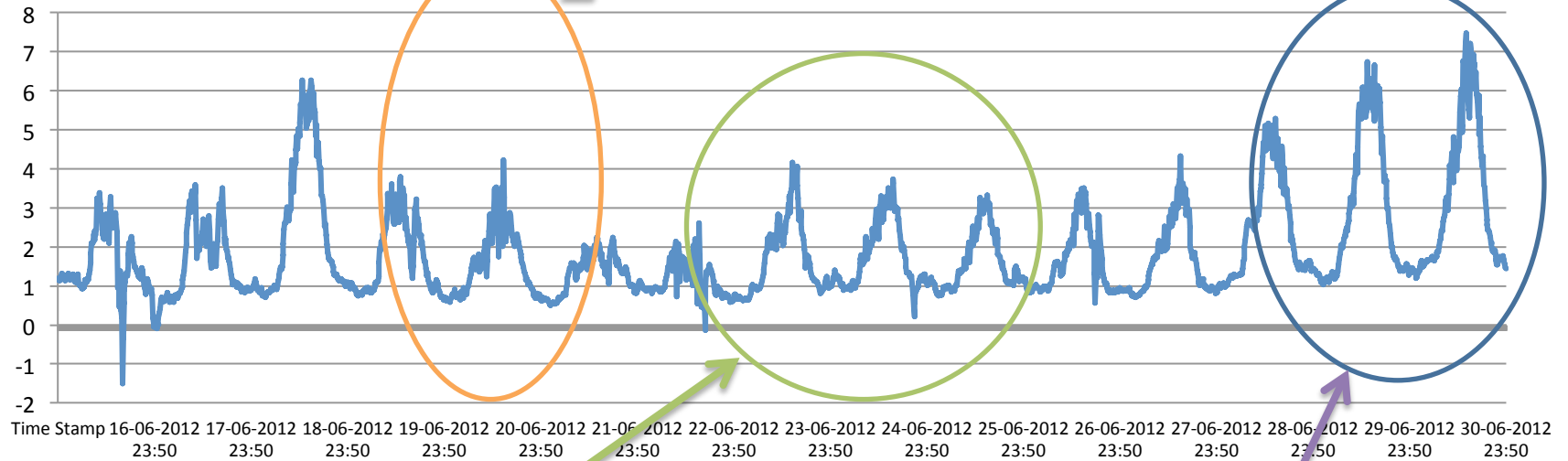
$$T_{\text{mrt}} = \left[(T_g + 273.15)^4 + \frac{1.1 \times 10^8 V_a^{0.6}}{\varepsilon D^{0.4}} \times (T_g - T_a) \right]^{1/4} - 273.15$$

T_g = the globe temperature (°C)
 V_a = the air velocity (ms^{-1})
 T_a = the air temperature (°C)
 D = the globe diameter (mm)
 ε = the globe emissivity



MRT (GALVANIZED-WHITE): 0.5°C – 3.5°C

MRT (GALVANIZED ROOF) - MRT(WHITE ROOF)

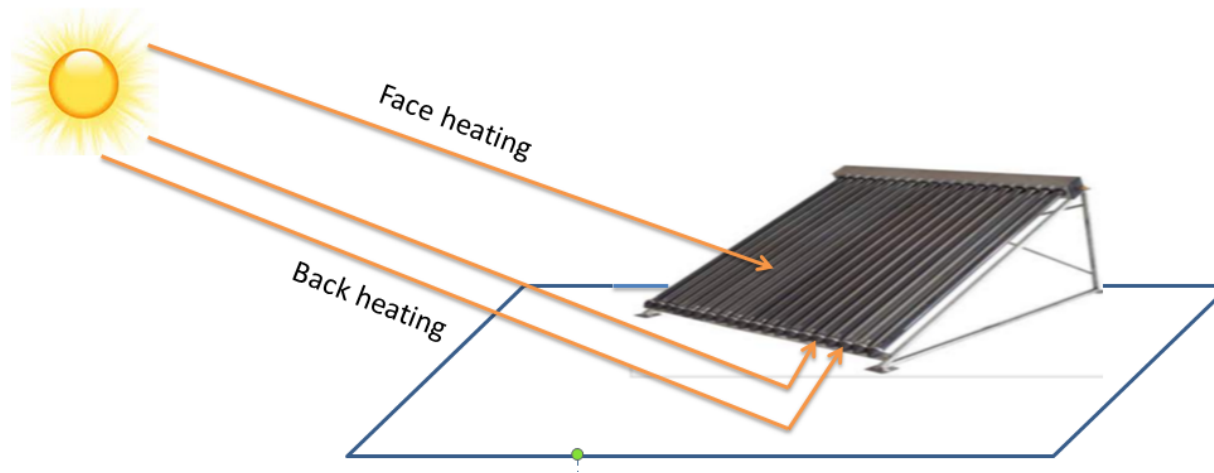


MRT (GALVANIZED – WHITE) : 0.8°C-3.7°C



MRT (GALVANIZED – WHITE) = 1.2 °C – 7.5 °C.

ADVANTAGES & APPLICATIONS



Advantages:

1. Increases **thermal comfort** for dwelling residents. Result in **health benefits, productivity**.
2. Decreased thermal stress will increase the **longevity of the material**.
3. Increased thermal comfort will **reduce energy use** due to reduced fan use.
4. Mass implementation will have **Climate impact and reduce Urban Heat island effect**.

Thank You!

Any
Questions????



Special Thanks to



Designer, MD



President

