

Solar Thermal Assisted 60TR CGAM Chiller Systems
Measuring and Verification Evaluation Report
2021

Assessment Period: APRIL – SEPT 2021

Prepared for:



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I. DATA MEASUREMENT

Kilowatts per Hour (kWh) - HOBO Data Recorder
 External Temperature - Actual daily recording

II. PROJECT OVERVIEW

These facility chillers were installed 12 years ago with two Trane “60TR CGAM Chiller Systems” to provide cooling for the cooling tunnel where cheese products are stored. The original agreement was to install the Solar Collector systems at its original location beside the cooling tunnel facility and by early next year Mondelez was to relocate the 2 chiller units to a new location. Due to the late awarding of the contract for this project, Mondelez decided to wait for the relocation of the CGAMs and install the Solar Collector systems at the new location. With this rescheduling of the project, FALKON 2B had to prepare a framing structure plan that will carry the Solar Collector systems over the CGAMs.

The chilled water piping from the original location was closer or shorter in length compared to the new location which is 30 meters father away.

The cold storage rooms where the evaporators are located were not disturbed but the supplied cooling was modified to accommodate the production area. Our observation was mainly focused on the CGAM units. We assumed that the temperature settings in the cold storage rooms were maintained during our data gathering period and the heat load of the cold storage rooms were mainly for the storing of cheese products.



FALKON 2B partnered the F1 Solar Collector (thermodynamic) system with these two existing 60TR CGAM systems. The schedule for completing this project was also affected by the COVID 19 pandemic wherein Mondelez had to implement its health protocols.

The sequence of tasks were:

1. Project was awarded in December 2020 – This installation required a structural framing for the 20 Solar Collectors to match the two CGAM systems’ requirements. Mondelez and FALKON 2B (F2B) agreed that:
 - a. F2B will construct a framing structure to carry the load for the 20 Solar Collector system including live load for maintenance personnel.

- b. Install the F1 Solar Collector system on top of the CGAM systems' location and have the refrigerant piping of the F1 system end beside the existing CGAM units' piping before connecting to the CGAM condensers.
- c. Prior to cutting of the CGAM refrigerant line, the existing refrigerant will be removed.
- d. F2B did a pressure test for the Solar Collector system prior to the connection while Mondelez consultants and Mondelez personnel were in observance. Mondelez approved the test.
- e. Prior to the connection of the Solar Collector systems to the CGAM refrigerant lines, F2B verified again with Mondelez consultants/personnel if they wanted a bypass line to which they replied that *it was not needed*. F2B then proceeded to connect the F1 Solar Collector/thermodynamic system to the existing CGAM unit's refrigerant piping before the condenser of the existing CGAMs.
- f. After the connection was completed, F2B performed another pressure test to make sure that the system did not have any leaks.
- g. The recharging of the CGAM systems with refrigerant was done and verified by Mondelez and its consultants.
- h. F2B together with Mondelez and CBRE performed the commissioning of the systems.

2. The next step was for F2B to start the data gathering of the kilowatt-hour consumption of the CGAM systems with the Solar Collector systems. There was a delay due to stormy weather. The data



recording that was gathered for the CGAM system prior to the Solar Collector system was done at the original location. The data recording for the power consumption with F1 Solar Collector systems was from August to September. The recording of the power consumption with the F1 Solar Collector system had interruptions due to various matters. Initially, CBRE performed test runs of the CGAMs right after the relocation work was done. Around July the monsoon season started which also interrupted the data gathering. In addition to these interruptions, the government instituted pandemic protocols which everybody had to comply with.

Installation Overview:

- The average sun hours of the Solar Collector systems we installed is based on 8 hours per day per year.
- The new CGAM units' location is 30 meters father from the original location where our power consumption data was recorded.
- The cold storage room supplied by these CGAMs increased after our F1 Solar Collector were installed.

Data recording:

- The data recording equipment used was the **HOBO - kWh Monitoring Kit – UX90 with WattNode Sensors**. The CTs were connected to each single cable of the 3-phase main power panel on the CGAM unit. Since our CTs connected with each cable, our data results were multiplied by 2 to get the total power consumption.



III. INSTALLED SYSTEM

The Solar Collector systems were partnered with the existing 12-year-old 60TR Trane CGAM Chiller systems. These systems supply cooling for the Cooling Tunnels with food products. After the relocation of the CGAM chillers with the F1 Solar Collector systems, the area that was supplied with cooled air had increased.

IV. BASELINE DATA

The baseline data for this project was the consumption of the existing CGAM #2 chiller system at the original site. We have recorded three weeks data with the Solar Collector system and two weeks without the Solar Collector system.

V. POST DATA

The power consumption data collected is shown on the next pages.

The post-implementation power and energy measurements were compared to that of the baseline and the savings calculated from the same, as such representing what the consumption was before and after the F1 Solar Collector installation.

VI. LIKE-FOR-LIKE COMPARISON

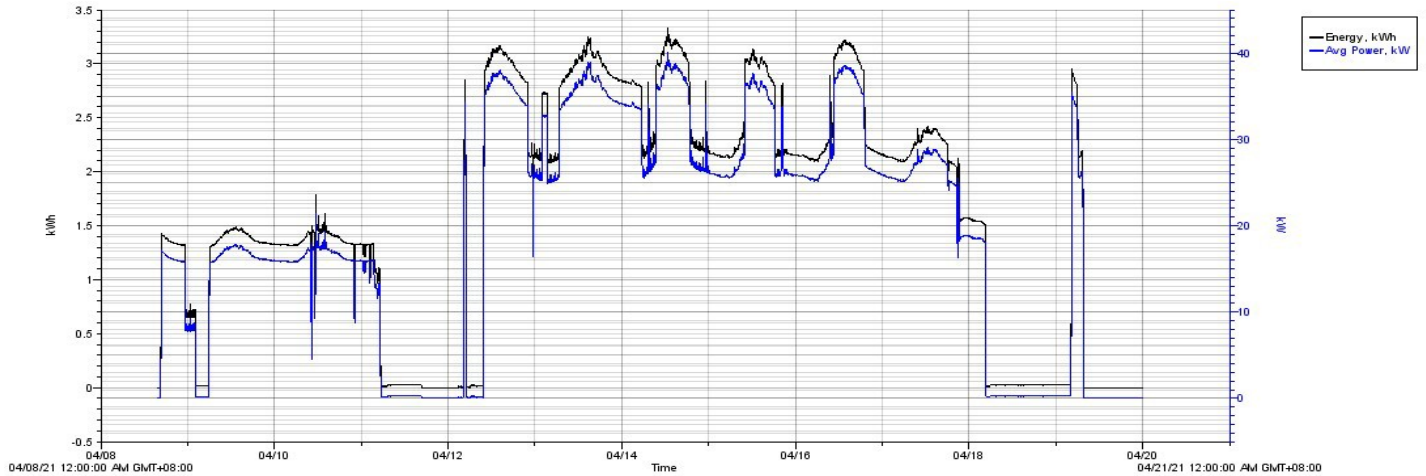
To ensure a credible data comparison of Baseline vs. Post data, the following principles have been used:

- i. Exact like for like system run times
- ii. As near as possible external ambient temperature

VII. SAVINGS

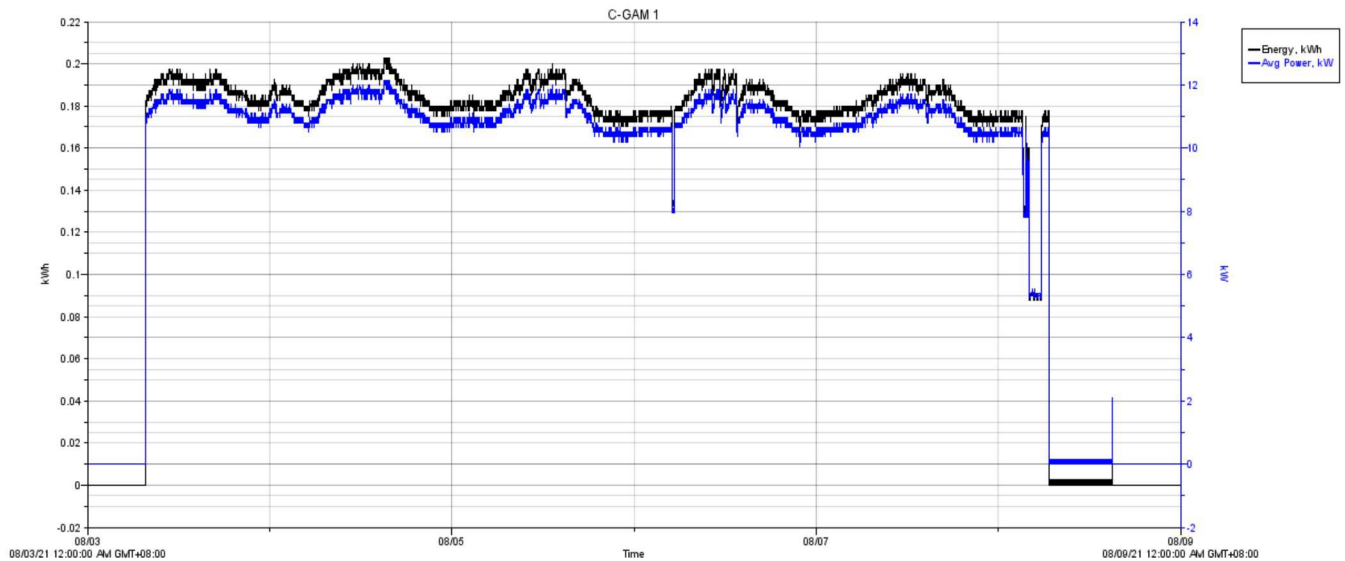
The data logging provides the recorded data over the period of evaluation to date.

Next pages are the raw graphs from our **HOBO** equipment.

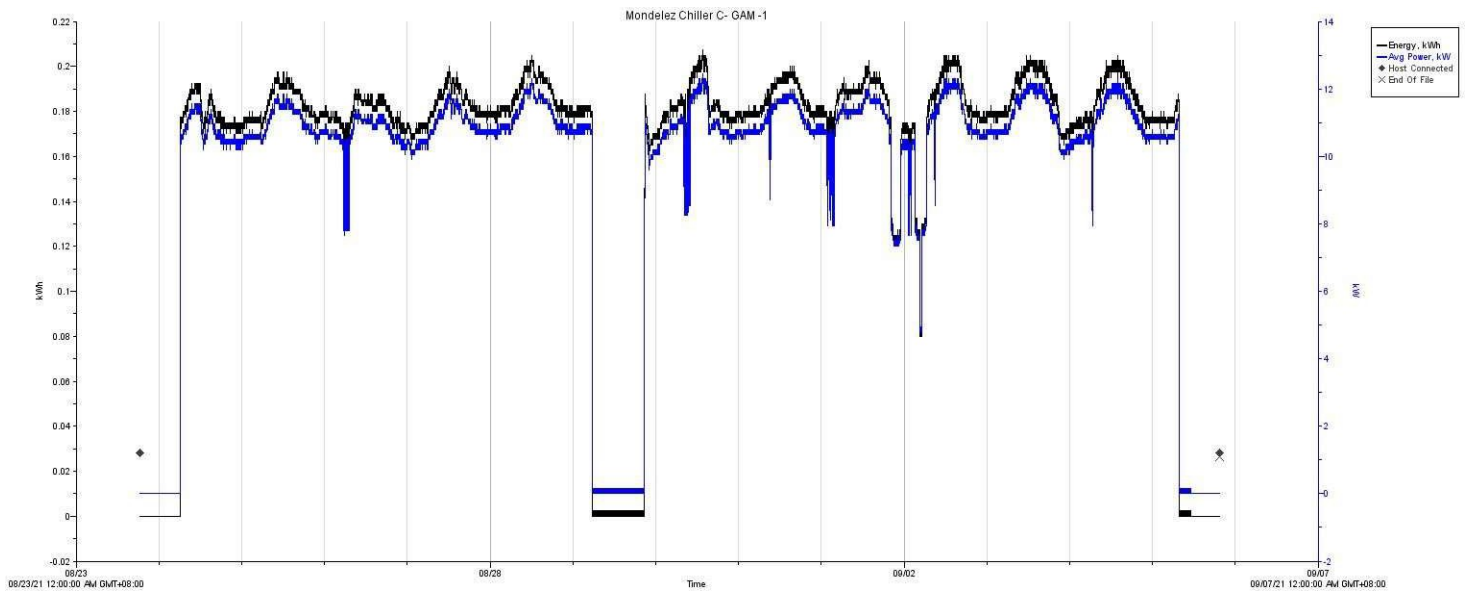


**HOBO – 10 DAYS READING WITHOUT SOLAR COLLECTOR
APRIL 4, 2021 TO APRIL 20, 2021**

The readings from April 8 to April 12 will be disregarded for our data comparison because there were 2 compressors having problems at that time.

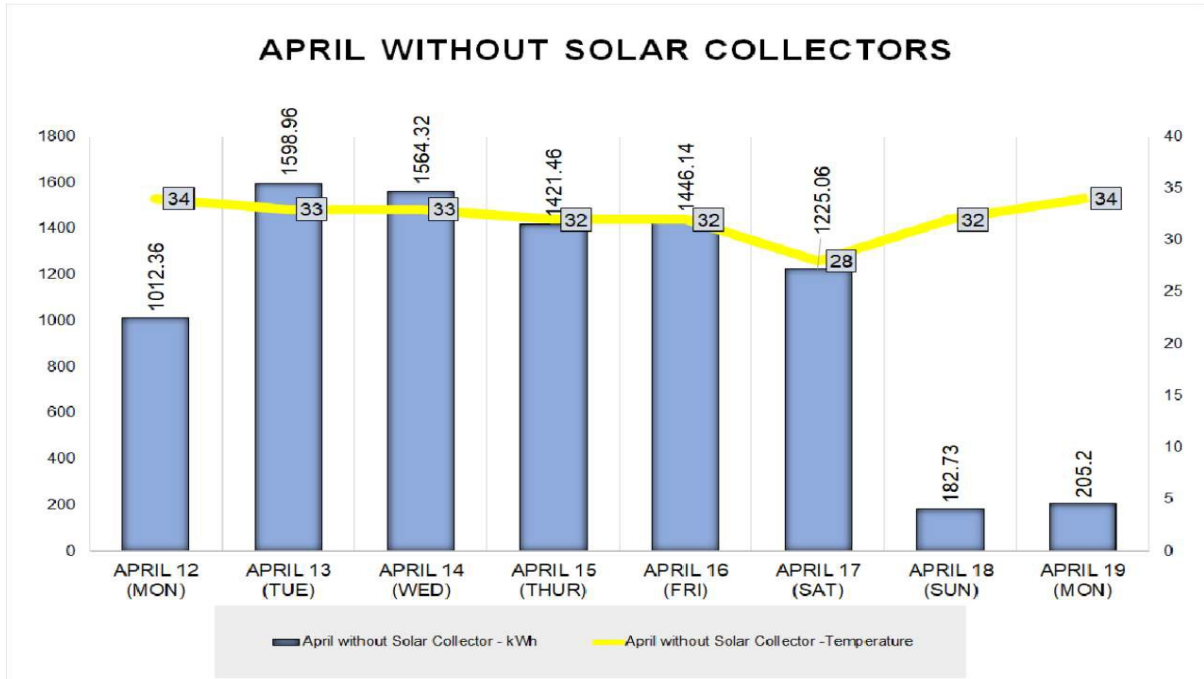


**HOBO – 4 DAYS READING WITH F1 SOLAR COLLECTOR SYSTEM
AUGUST 4, 2021 TO AUGUST 8, 2021**

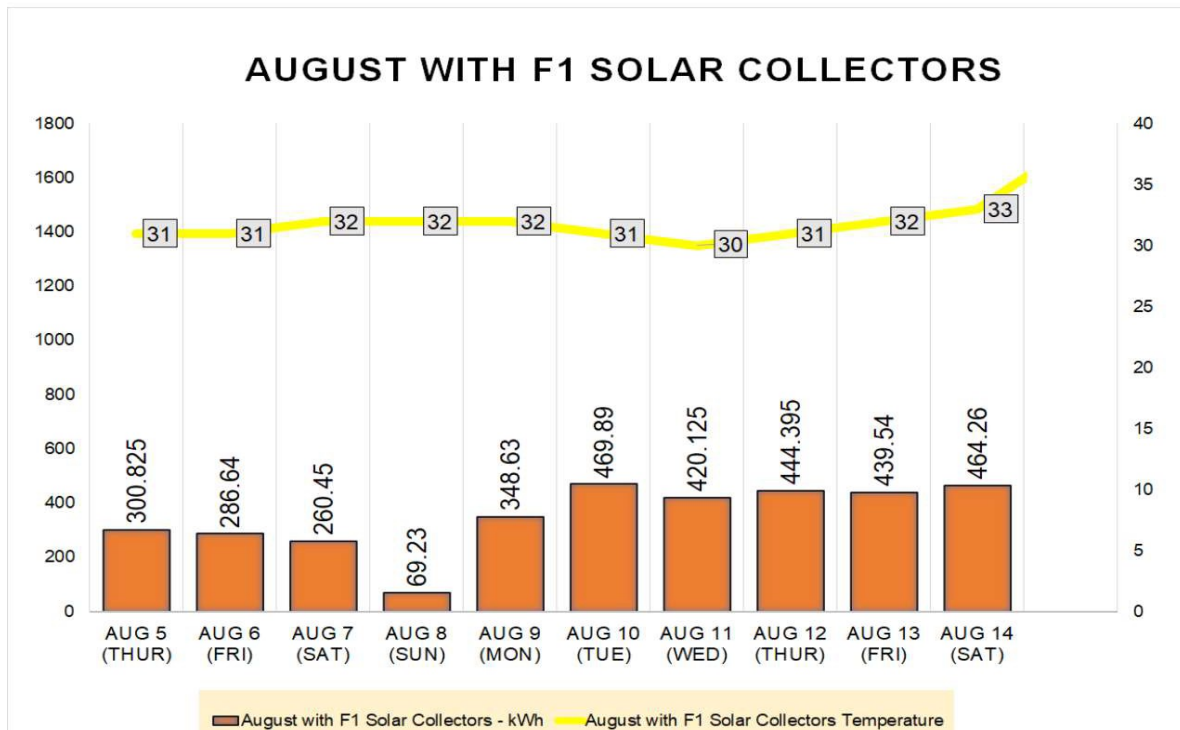


**HOBO – 13 DAYS READING WITH F1 SOLAR COLLECTOR SYSTEM
AUGUST 24, 2021 TO SEPTEMBER 6, 2021**

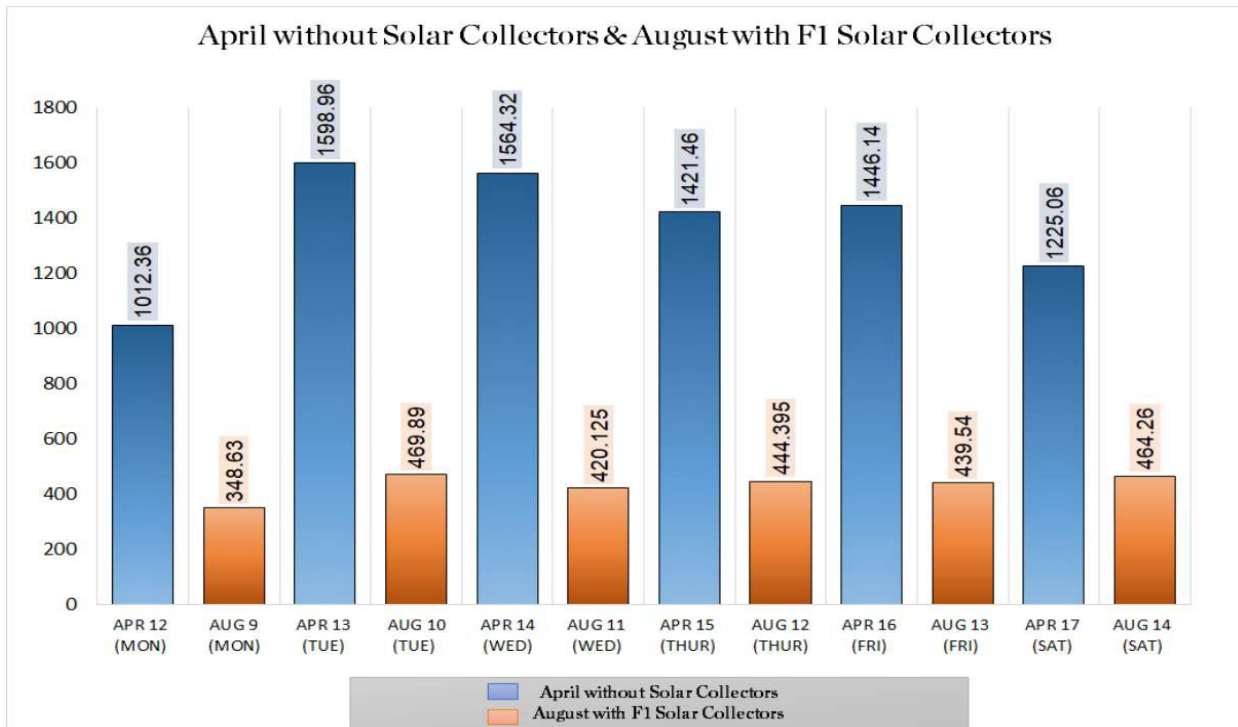
NOTE: These graph data above were taken using HOBO CTs connected to a single CGAM power cable. Therefore, the readings are multiplied by 2 to compensate the 2 cables per terminal.



AVERAGE DAILY KWH DATA



AVERAGE DAILY KWH DATA WITH F1 SOLAR COLLECTOR SYSTEM



LIKE FOR LIKE COMPARISON BETWEEN NONE SOLAR ASSISTED AND WITH F1 SOLAR COLLECTOR SYSTEM

NOTE: PER ENGINEER STAN OF MONDELEZ, THE ORIGINAL LOCATION READING INCLUDED CONSUMPTION FROM VARIOUS OTHER EQUIPMENT LIKE CONVEYORS. WE CAN ASSUME THESE VARIOUS PIECES OF EQUIPMENT TOTALING AROUND 300 KWH AVERAGE DAILY. THUS, THIS WILL BE DEDUCTED IN OUR CALCULATION BELOW.

WITHOUT SOLAR COLLECTOR SYSTEM = 1,400 kWh average daily – 300kWh = 1,100 kWh
 WITH F1 SOLAR COLLECTOR SYSTEM = 440 kWh average hourly
 SAVINGS = 60% average SAVINGS

We can safely assume that due to the annual monsoon season in the Philippines we can get an average savings of 50%.

VIII. CONCLUSION

This shows that a 12-year-old Trane 60TR CGAM System can achieve ample savings when partnered with the F1 Solar Collector/Thermodynamic system.

The normal kWh consumption graph for systems with F1 Solar Collector system shows a lower power consumption. We also realize that the CGAM compressors are running with less stress, quieter and thus perform much better with the F1 Solar Collector systems. The hotter the sun gets the more savings and efficient the CGAMs will run.



“THE HOTTER IT GETS THE MORE EFFICIENT IT BECOMES”

IX. APPENDIX

APRIL WITHOUT SOLAR COLLECTOR		
	kWh	Temperature
APRIL 12 (MON)	1012.36	34
APRIL 13 (TUE)	1598.96	33
APRIL 14 (WED)	1564.32	33
APRIL 15 (THUR)	1421.46	32
APRIL 16 (FRI)	1446.14	32
APRIL 17 (SAT)	1225.06	28
APRIL 18 (SUN)	182.73	32
APRIL 19 (MON)	205.2	34

AUGUST WITH F1 SOLAR COLLECTORS		
	kWh	Temperature
AUG 5 (THUR)	300.825	31
AUG 6 (FRI)	286.64	31
AUG 7 (SAT)	260.45	32
AUG 8 (SUN)	69.23	32
AUG 9 (MON)	348.63	32
AUG 10 (TUE)	469.89	31
AUG 11 (WED)	420.125	30
AUG 12 (THUR)	444.395	31
AUG 13 (FRI)	439.54	32
AUG 14 (SAT)	464.26	33