



**Measurement &  
Verification Sdn. Bhd.**  
An Accredited Energy Services Company



**Menara KEN TTDI**

**GREEN BUILD CONFERENCE 2022**

**ESG: Accelerating  
Sustainability  
in Malaysia's  
Real Estate Sector**

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14 JULY 2022

# Speaker's Profile



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**Measurement &  
Verification Pte Ltd**





# Agenda

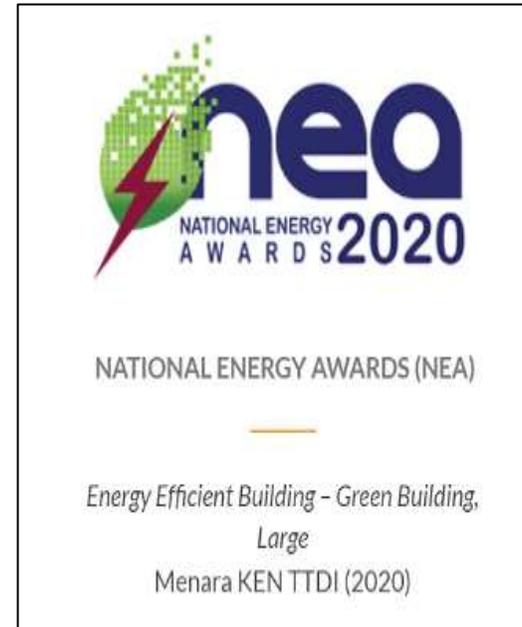
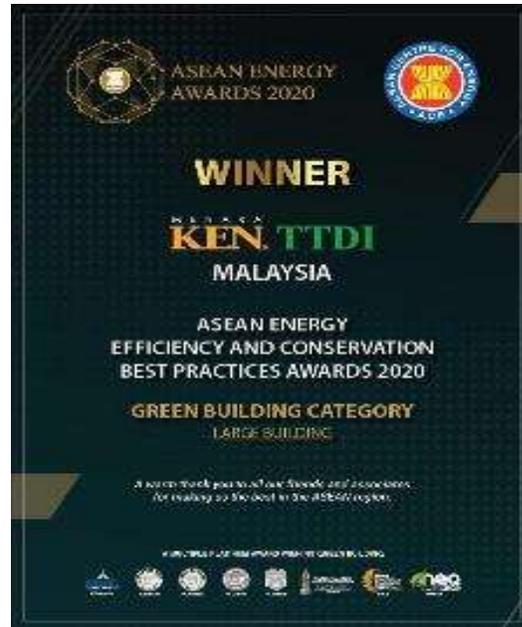
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- **Building Information**
- ACMV System Design Configuration.
- Post Project Completion System Performance.
- Project Benefits.





# Green Building Accolades



Malaysia  
GreenRE

Platinum  
Award



Singapore BCA  
Green Mark

Platinum  
Award



US GBC  
LEED

Platinum  
Award





# How to build such an outstanding office tower?

## #1: Clear vision

To build the greenest building in Malaysia.

## #2: Grit

Unwavering perseverance to find, to learn and to implement the best engineering solutions.

## #3: Best and truest standards

Demands for the best then measure+verify, measure+verify and measure+verify.



Sam Tan  
Group MD, Ken Holdings



Lee Eng Lock  
Founder, M&V Pte Ltd

# Building Information

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Building Name:	Menara Ken TTDI
Address:	Jalan Burhanuddin Helmi, TTDI, Kuala Lumpur
Year completed:	2017
Building type:	300,000 sqft, 13 Storey, Grade A office tower with retail, F&B, 523 seat theatre, function rooms, art gallery, rooftop gym and swimming pool.
Unique M&E features:	Super high efficiency air-conditioning system with thermal storage. Individual control and available 24x7. Natural daylight from façade and internal atrium.



MENARA  
**KEN.TTDI**

Spot cooling under the desk  
for receptionist

**THE PLATFORM.**  
PERFORMING ARTS THEATRE



Lobby temperature  
set at 28C

**Outdoor Infinity Pool**  
2,000 sq. ft.



## Babel Gym

A beautiful 8,000 sq.ft. establishment at Rooftop aimed at creating an inspirational experience, filled with state-of-the-art gym equipment



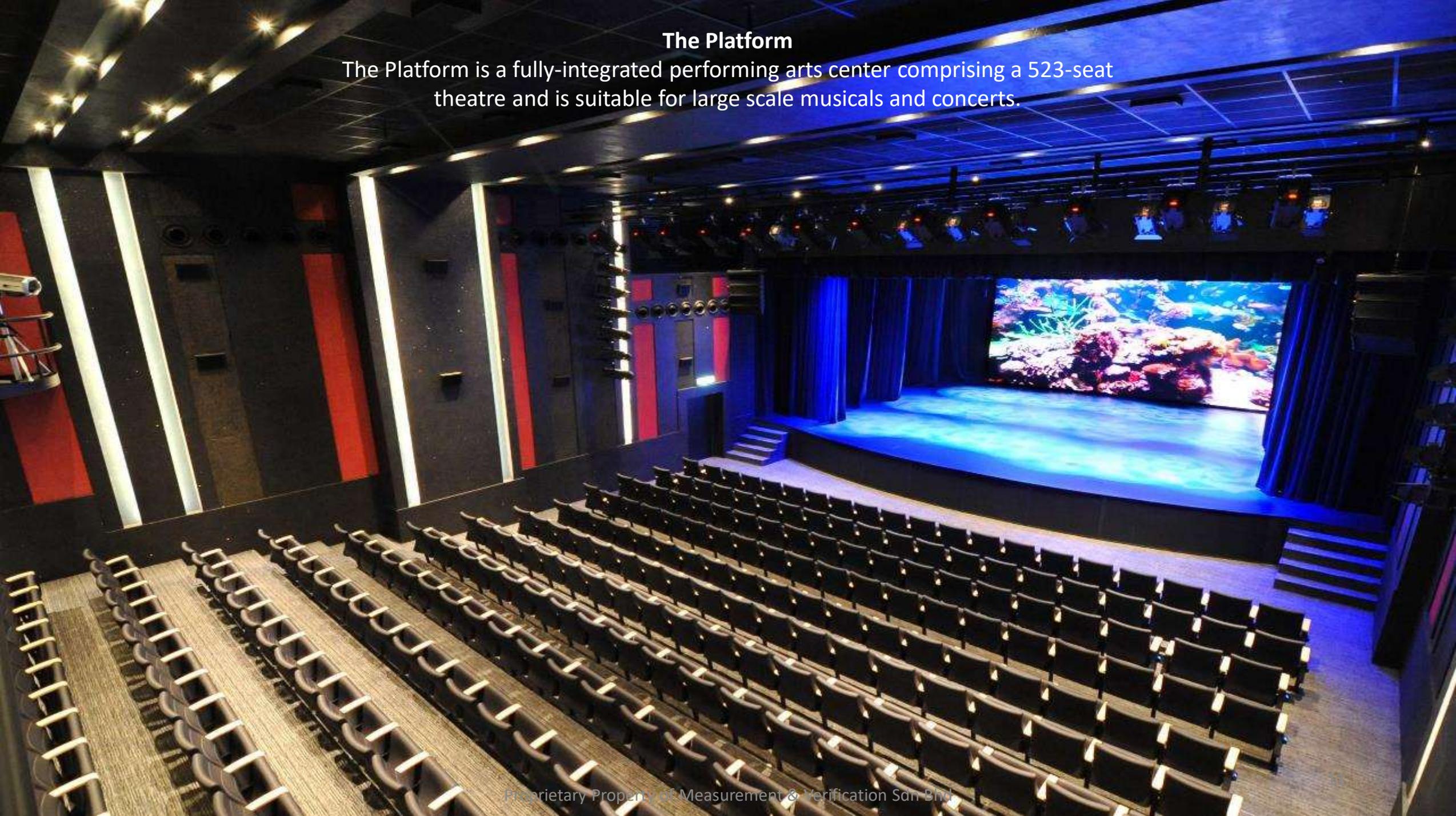
## KEN Gallery

Set in a 20,000 sq.ft. of space, the gallery is divided into four halls with different sections namely The Main Hall, Hall 1, Hall 2, Hall 3 and a conservation center.



## The Platform

The Platform is a fully-integrated performing arts center comprising a 523-seat theatre and is suitable for large scale musicals and concerts.





# Agenda

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- Building Information
- **ACMV System Design Configuration.**
- Post Project Completion System Performance.
- Project Benefits.



# Scope of Works in this GESP Project:



1. M&V was appointed as Energy Consultant.
2. M&V designed the ultra high efficiency Air Conditioning & Mechanical Ventilation System (ACMV) and guarantees the following energy efficiency:
  - 0.51 kW/RT for chiller plant
  - 0.14 kW/RT for airside
  - 0.65 kW/RT for Total System Efficiency with a tolerance of +/- 5% (ie 0.683 kW/RT)
3. M&V designed & built, and is currently maintaining the Energy Management System (EMS).

# ACMV System Design Configuration



## Major ACMV Equipment List

Item	Description	Quantity
1	Chillers 2 x 500RT VSD Chillers	2
2	Chilled Water Pumps	2
3	Condenser Water Pumps	3
4	Cooling Tower 6 cells	1
5	Auto Tube Cleaners	2
6	Make-up Water Tank	1
7	Make-up Water Pumps	1
8	Water Treatment Systems	1
9	TES water tank	1
10	TES Water Tank Pumps	4
11	Heat Exchanger	2
12	Heat Exchanger Pumps	2
13	Fresh Air AHU System	2
14	FCU System	259
15	Energy Efficiency Management System	1

### Chiller plant cooling efficiency

Chiller:	0.42 kW/RT
CHWP:	0.03 kW/RT
CWP:	0.03 kW/RT
CT:	<u>0.03 kW/RT</u>
Chiller plant:	0.51 kW/RT

### Airside efficiency

OA-AHU :	0.04 kW/RT
FCU :	<u>0.10 kW/RT</u>
Airside:	0.14 kW/RT

**Total System Efficiency: 0.65 kW/RT**

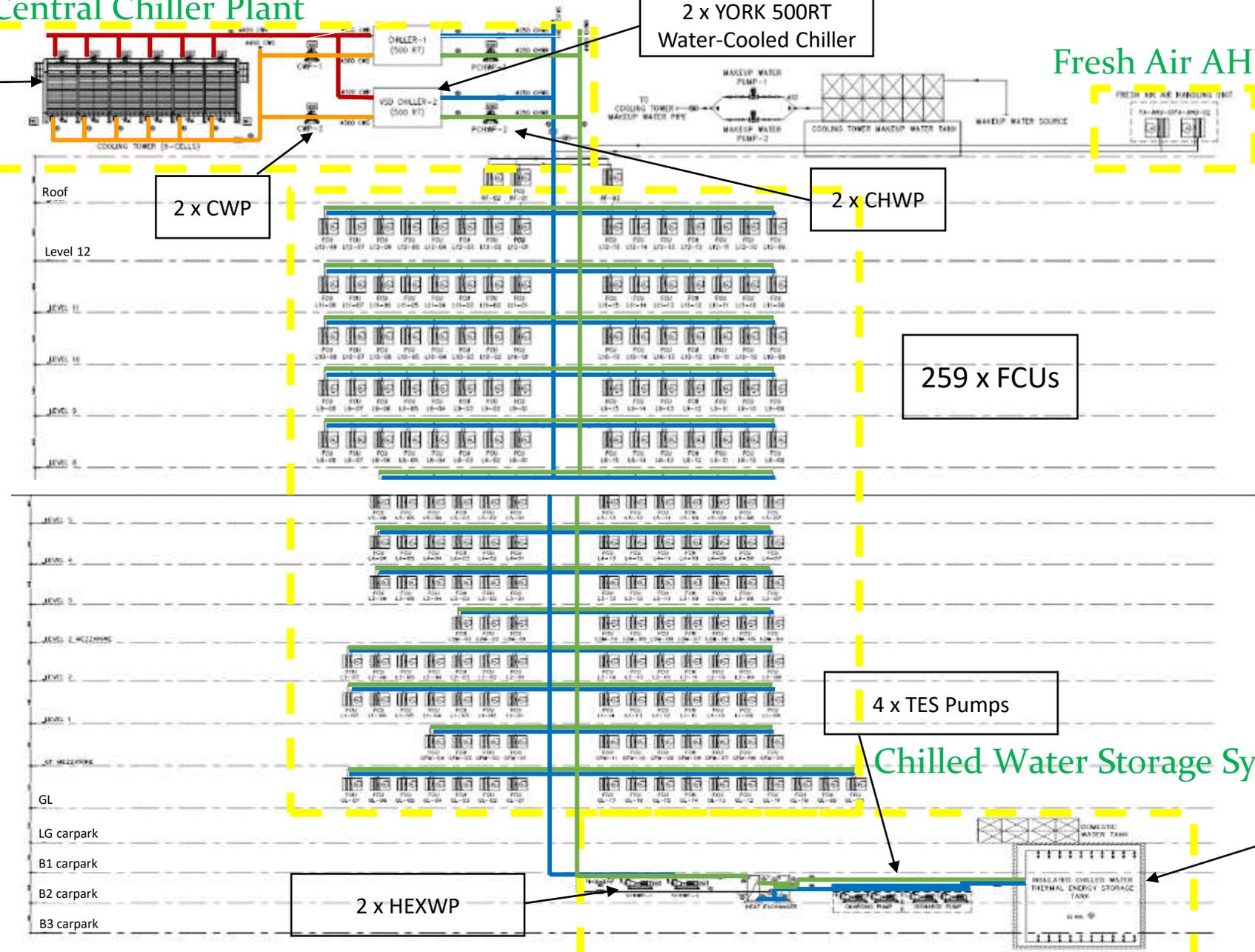
# Menara KEN TTDI Chilled Water Piping Schematic System

## Central Chiller Plant

6-cells Cooling Towers

2 x YORK 500RT Water-Cooled Chiller

Fresh Air AHU



2 x CWP

2 x CHWP

259 x FCUs

4 x TES Pumps

Chilled Water Storage System

TES Tank

2 x HEXWP

Roof  
Level 12  
LEVEL 11  
LEVEL 10  
LEVEL 9  
LEVEL 8  
LEVEL 7  
LEVEL 6  
LEVEL 5  
LEVEL 4  
LEVEL 3  
LEVEL 2  
LEVEL 1  
GL  
LG carpark  
B1 carpark  
B2 carpark  
B3 carpark

# ACMV System Design Configuration



## **Thermal Energy Storage (TES) Operation Strategy:**

Night (8 hours: 10 pm – 8am) : TES Storage with chiller

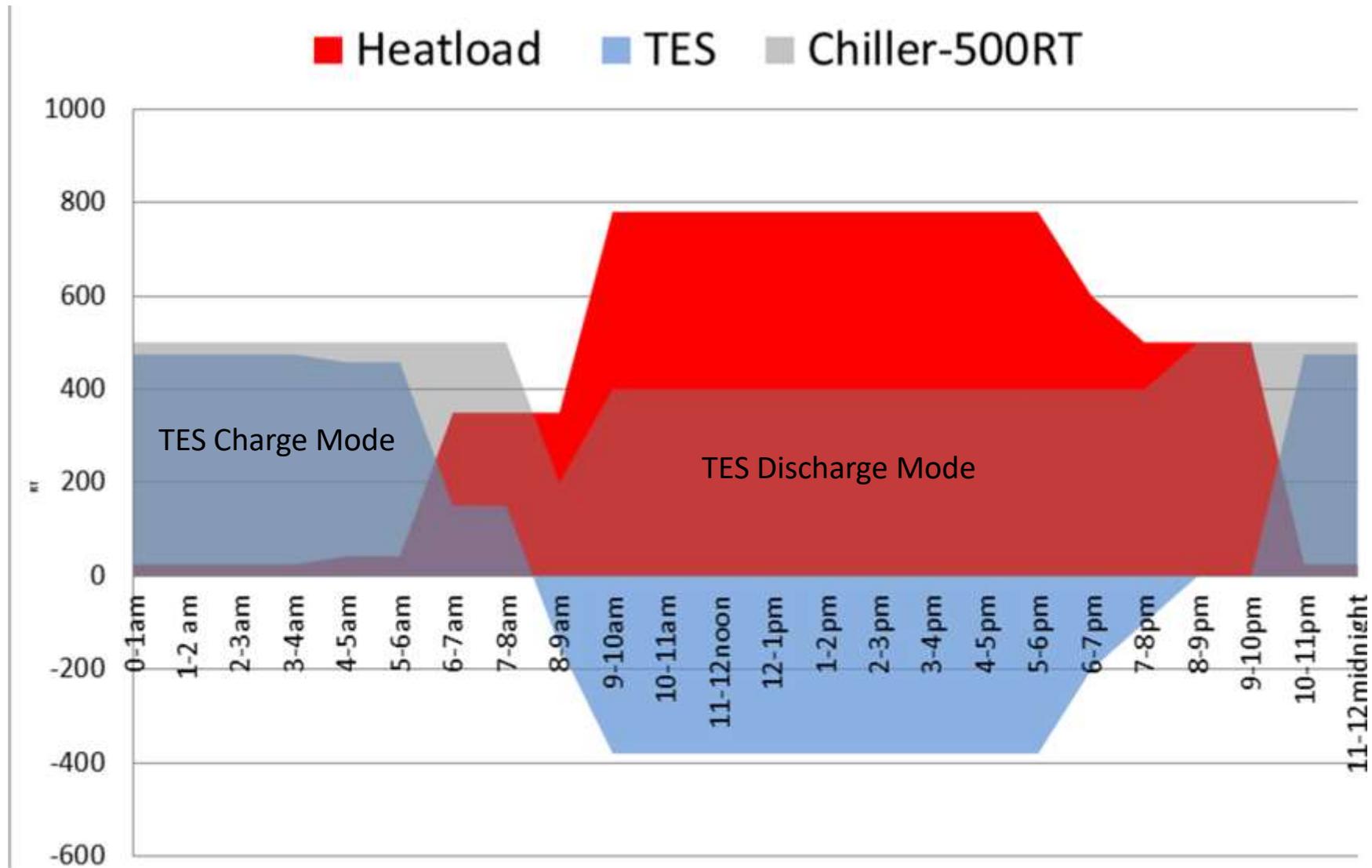
Day (14 hours: 8am -10pm) : TES discharging + chiller

**Comfort benefit:** 24 x 7 air-conditioning for MNC tenants.

**Opex benefit:** 40% cheaper off-peak period electrical tariff.  
Lower peak period kW demand.

**Capex benefit:** Reduce chiller size from 2 x 800RT chiller to 2 x 500RT.  
Eliminate small chiller to cater for low night and weekend load.

# ACMV System Design Configuration



# ACMV System Design Configuration

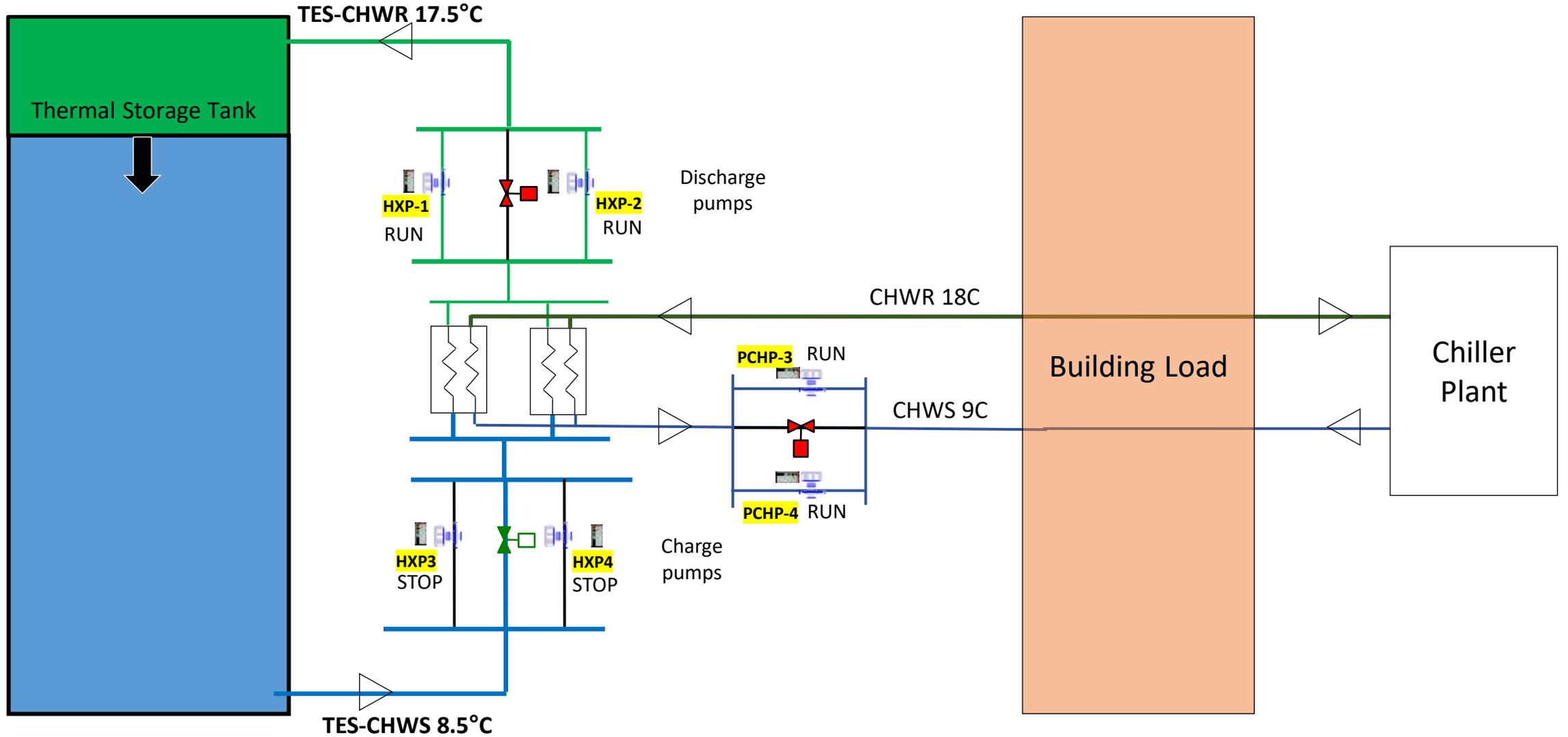


## Comparison of MNV Design HVAC System Electricity Charges

Summary	Design kWh/RTh	Max Demand (kW)	Annual MD Charge (RM)	Annual Peak kWh Charge (RM)	Annual Off peak kWh Charge (RM)	Annual Electricity Charge (RM)	Difference (With MNV)
Chiller Plant without TES	0.658	507	234,842	691,386	47,628	973,856	379,055
Chiller plant with TES at 0.65 kW/RT	0.650	325	150,540	408,845	224,640	784,025	189,223
Chiller Plant with Tes at MNV Design (0.52kW/RT)	0.52	250	115,800	314,496	164,506	594,802	

kW	RM39/kW per month
kWh Peak 8am-10pm	RM 0.31/kWh
kWh offpeak 10pm - 8am	RM 0.19/kWh

# TES Tank Discharge Mode (8am to 10pm)



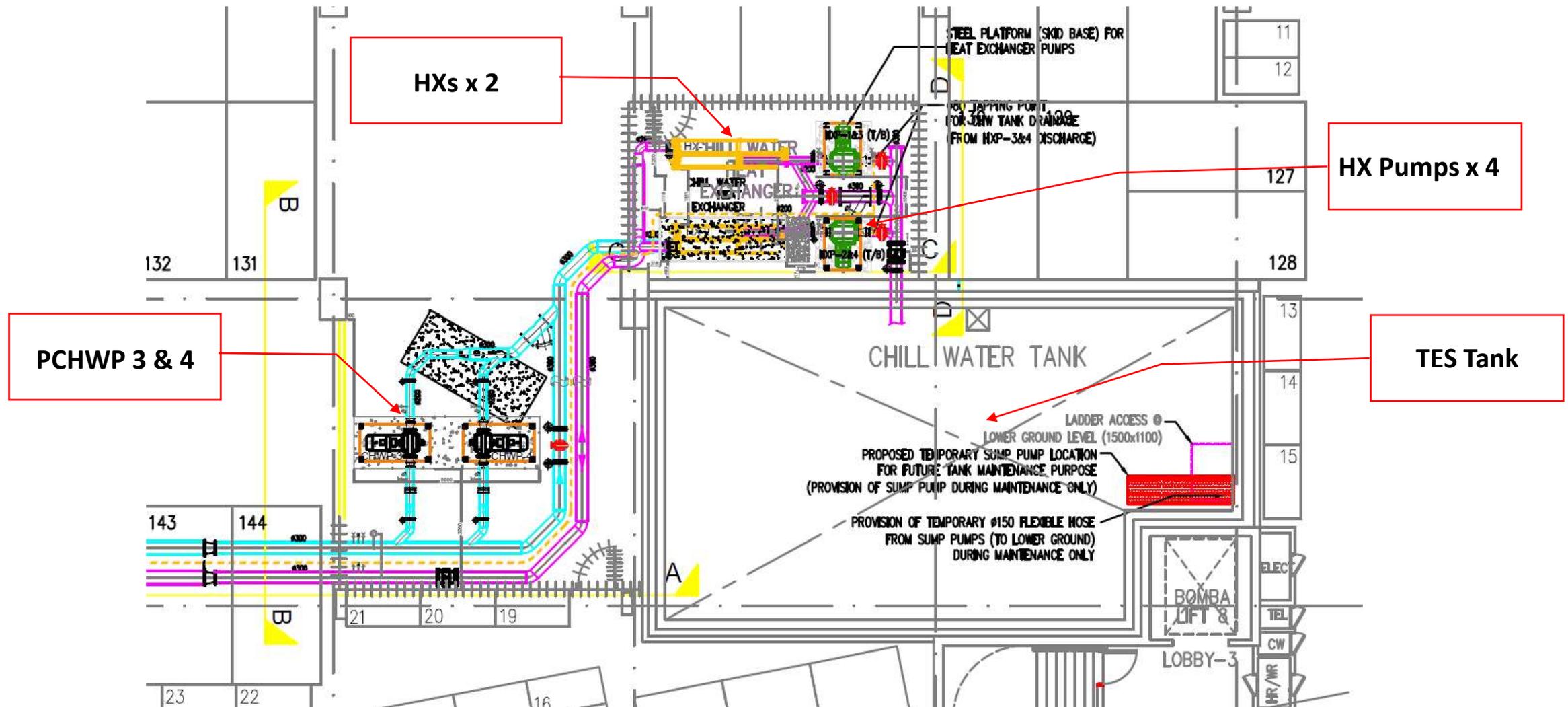
1. TES discharge mode stops when TES CHWST reaches 10.5C.
2. CHP continues at 10C CHWST





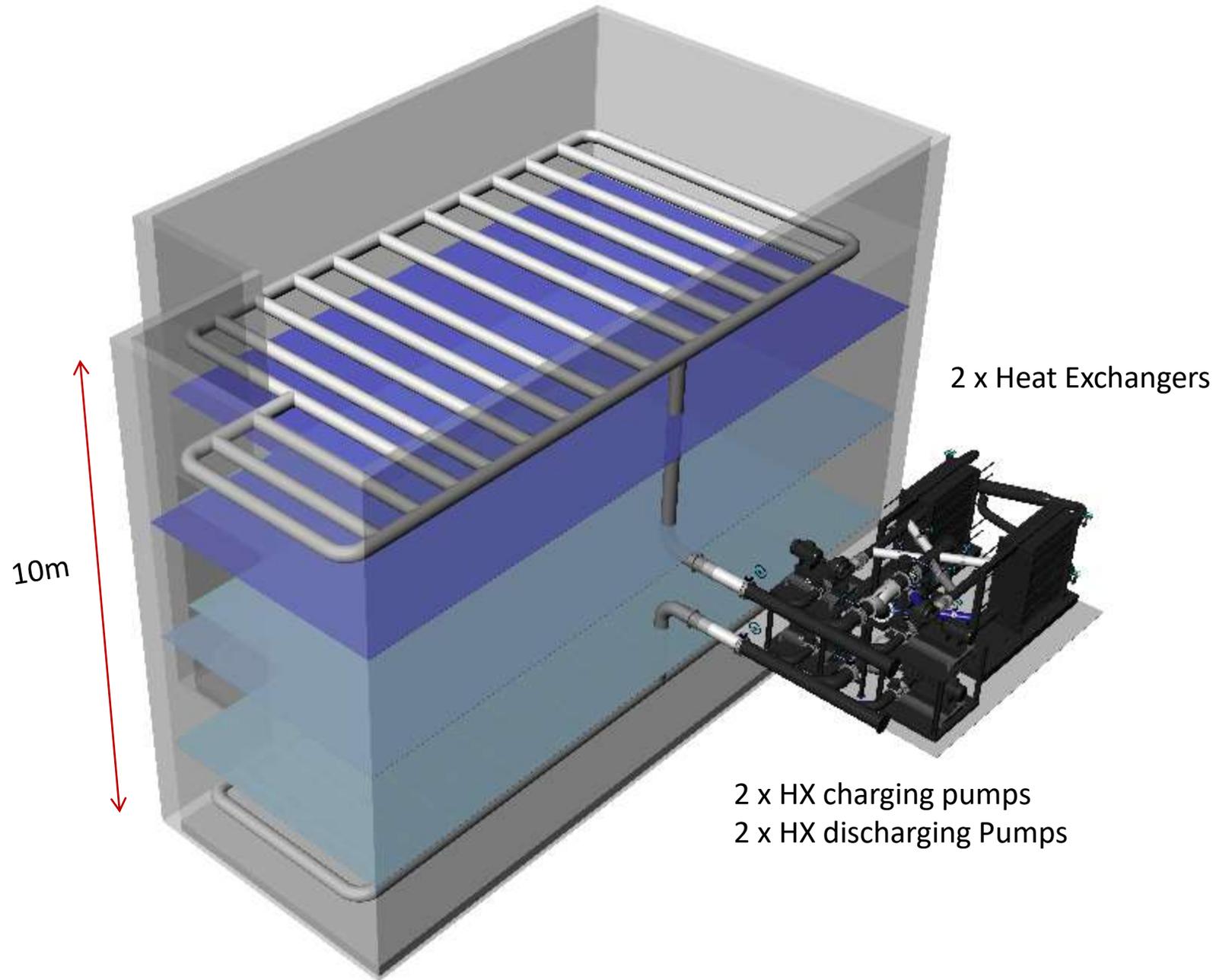
# Post Project Completion System Performance – Thermal Energy Storage (TES)

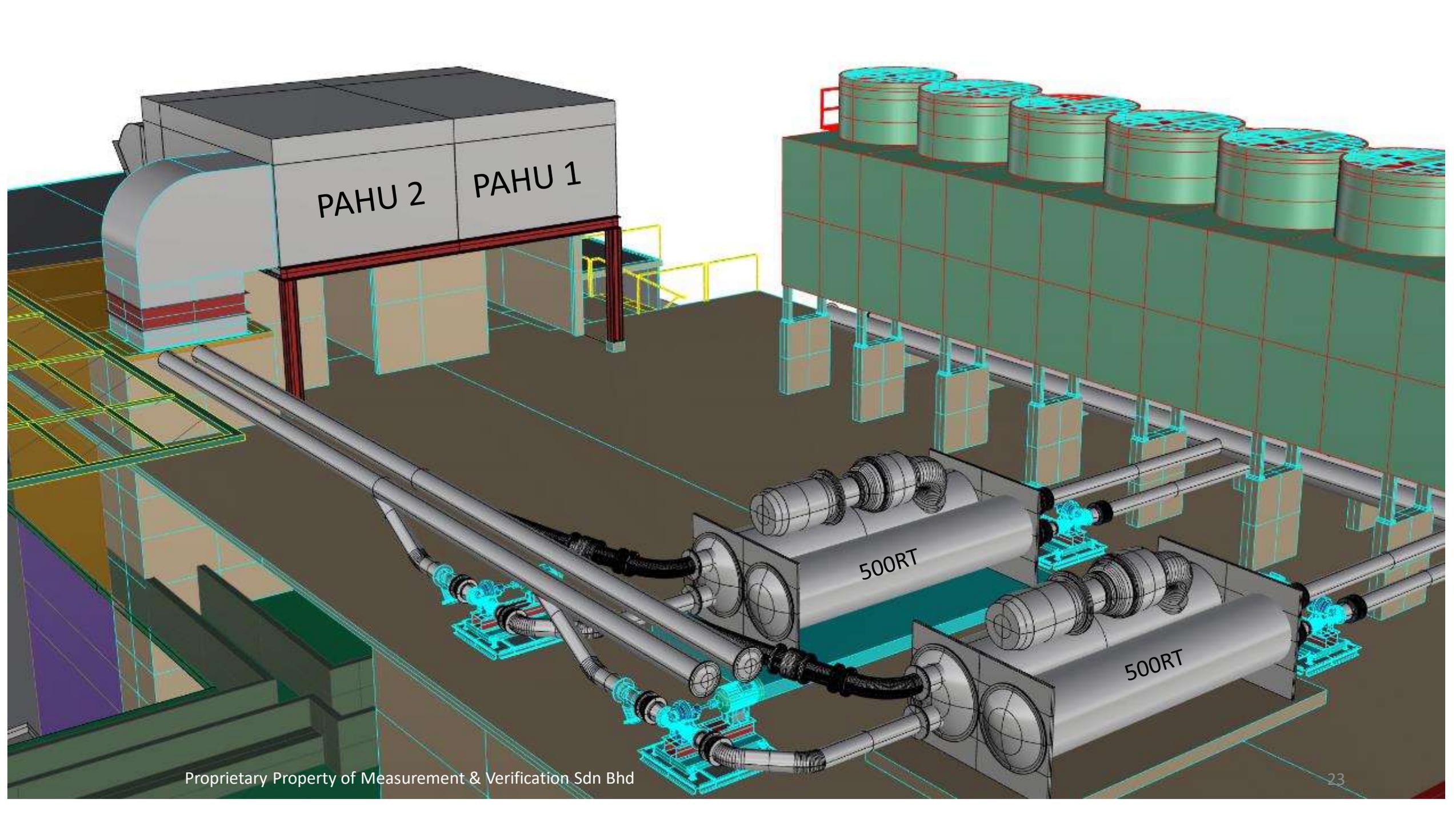
## Thermal Energy Storage & Heat Exchanger Build:

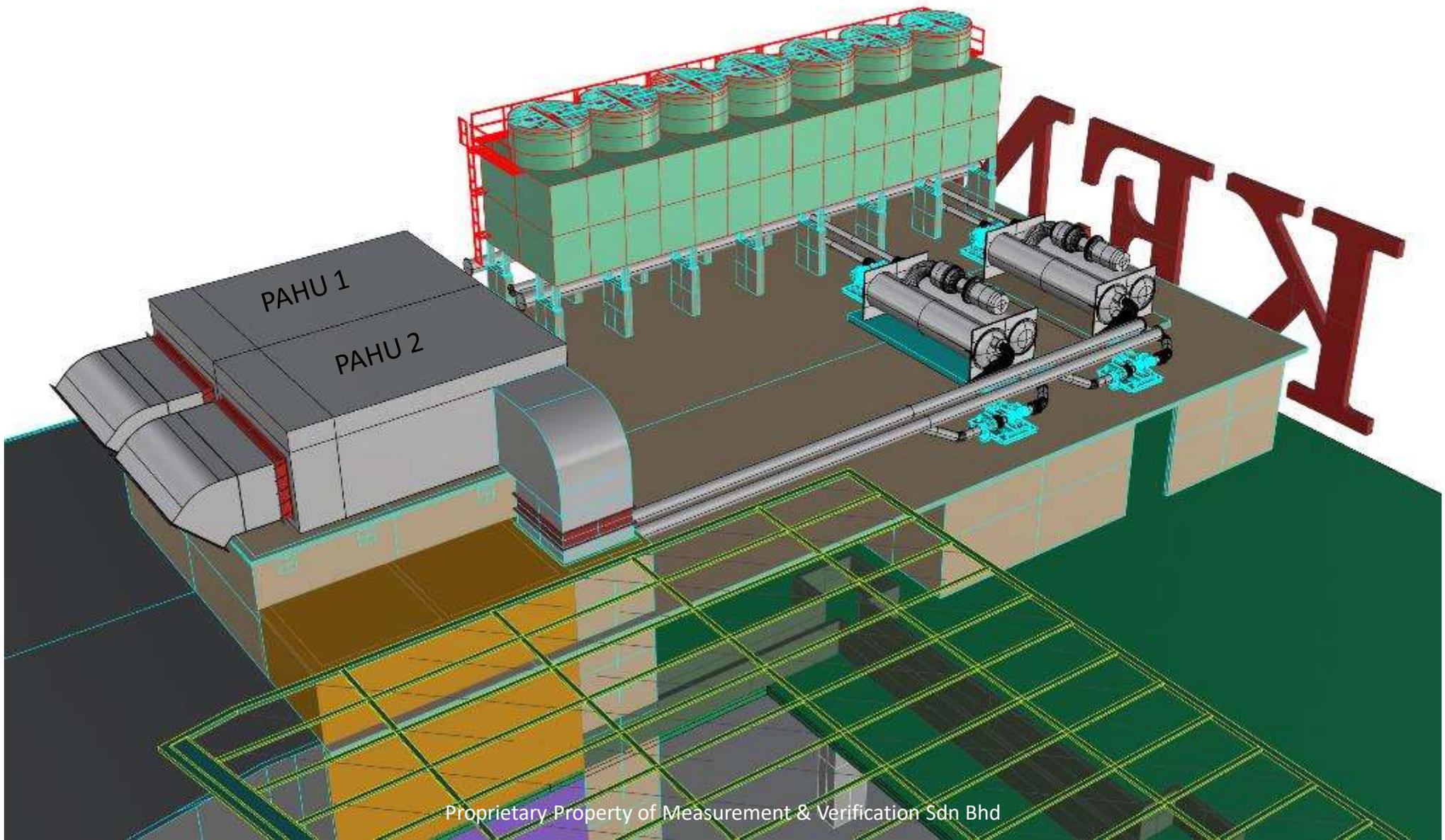


### TES Tank

Gross volume: 1,300 m<sup>3</sup>  
Effective Volume : 1,192 m<sup>3</sup>  
TES Tank cooling storage: 3,556 RTh  
TES Tank discharge capacity: 400 RT







# Agenda

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- Building Information
- ACMV System Design Configuration.
- **Post Project Completion System Performance.**
- Project Benefits.















Chiller Starter Panel



EEMS Panel



Variable Speed Drives (VSD)



Chiller Auto Tube Cleaner



Outside Air AHU



**Ultra Low Height, EC Motor  
Fan Coil Unit**



**Pre Fabricate Low  
Resistance Ducting System**

**Double glazed low-E  
glass lets natural light in  
but keep the heat out.**

Low Resistance CHW Piping System

BTU Meter



How approach temperature  
Heat Exchangers

Heat Exchanger



Double Stack HX Pumps  
To Save Space



TES Tank integrated into building structure  
3 Storey high: From B3 to B1



# Post Project Completion System Performance – 2018



- Home
- Chiller Plant
- Storage Tank
- OA-AHU
- Digital Power Meter
- Floor Overview
- Equipment Network

## MENARA KEN ENERGY EFFICIENCY MANAGEMENT SYSTEM (EEMS)

Real-Time Efficiency & Power Consumed	
Total Chilled Water Ton	272.2
Total Air Side Ton	271.7

Water Side System Efficiency	
Chiller (CH)	0.475
Chilled Water Pump (PCHWP)	0.035
Condenser Water Pump (CWP)	0.032
Cooling Tower (CT)	0.017
Heat Exchanger Pump (HXP)	0.000
Water Side System	0.559 <span style="border: 1px solid red; padding: 2px;">0.559</span>

Air Side System Efficiency	
Outside Air AHU (OA-AHU)	0.076
Chilled Water FCU (FCU)	0.017
Air Side System	0.031 <span style="border: 1px solid red; padding: 2px;">0.031</span>

Water Side System	
Chiller (CH)	129.3
Chilled Water Pump (PCHWP)	9.5
Condenser Water Pump (CWP)	8.8
Cooling Tower (CT)	4.5
Heat Exchanger Pump (HXP)	1.62
Water Side System	153.8

Air Side System	
Outside Air AHU (OA-AHU)	5.1
Chilled Water FCU (FCU)	3.4
Air Side System KW	8.5



Summary Of Building Water Side Energy Consumption	
Instantaneous System kW used	152.1
kWh Used for Today	746.7
kWh Used for the Month	5369.2
MWh Used for the Quarter	144.3
MWh Used for the Year	778.3
TonHour Used for Today	1337.5
TonHour Used for the Month	9993.8
Kilo TonHour Used for the Quarter	258.9
Kilo TonHour Used for the Year	1388.1
kW/Ton (Daily)	0.558
kW/Ton (Monthly)	0.537
kW/Ton (Quarterly)	0.557
kW/Ton (Yearly)	0.561 <span style="border: 1px solid red; padding: 2px;">0.561</span>

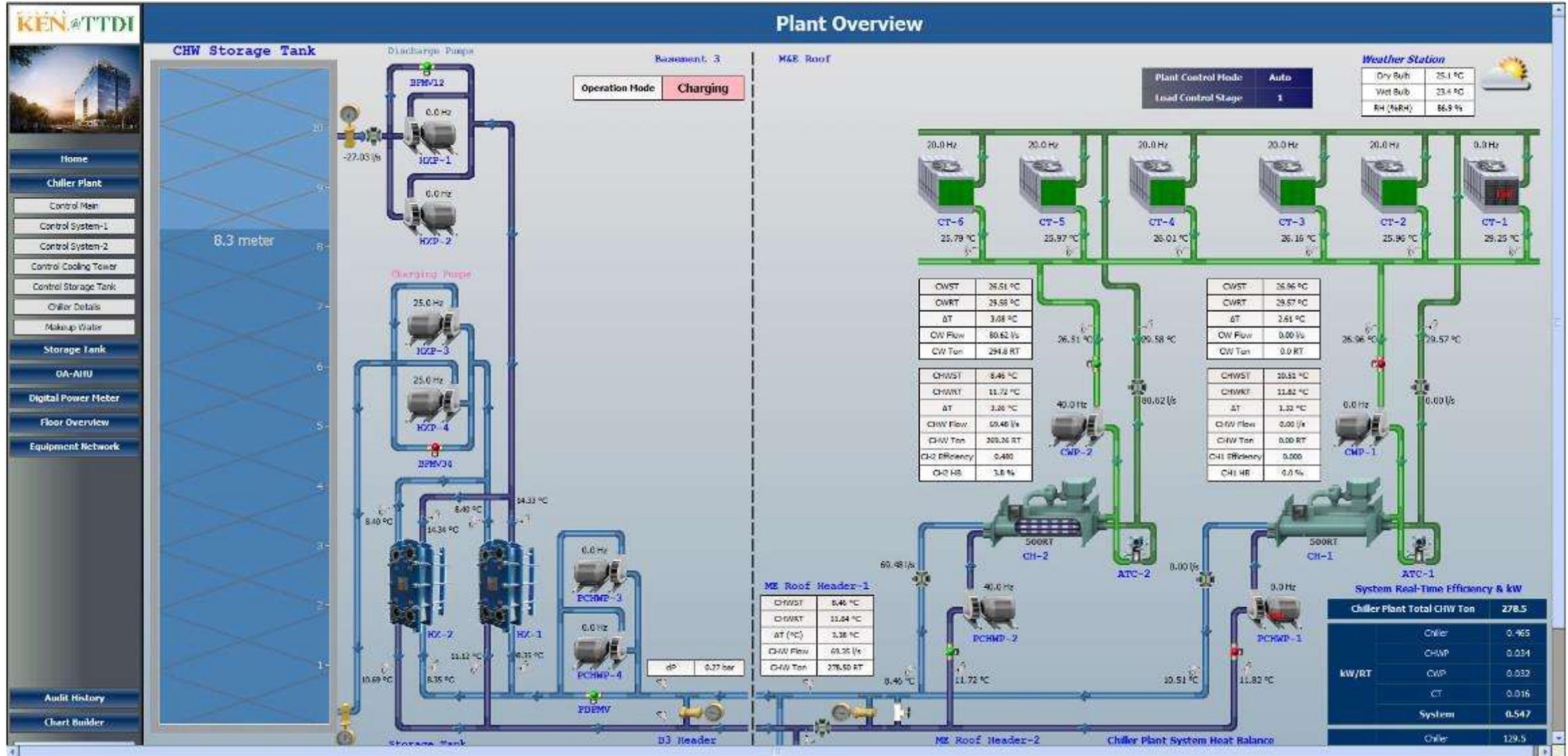
Summary Of Building Air Side Energy Consumption	
Instantaneous System kW used	8.5
kWh Used for Today	39.9
kWh Used for the Month	923.3
MWh Used for the Quarter	26.1
MWh Used for the Year	145.2
TonHour Used for Today	1338.1
TonHour Used for the Month	9957.9
Kilo TonHour Used for the Quarter	254.2
Kilo TonHour Used for the Year	1395.1
kW/Ton (Daily)	0.030
kW/Ton (Monthly)	0.093
kW/Ton (Quarterly)	0.102
kW/Ton (Yearly)	0.104 <span style="border: 1px solid red; padding: 2px;">0.104</span>

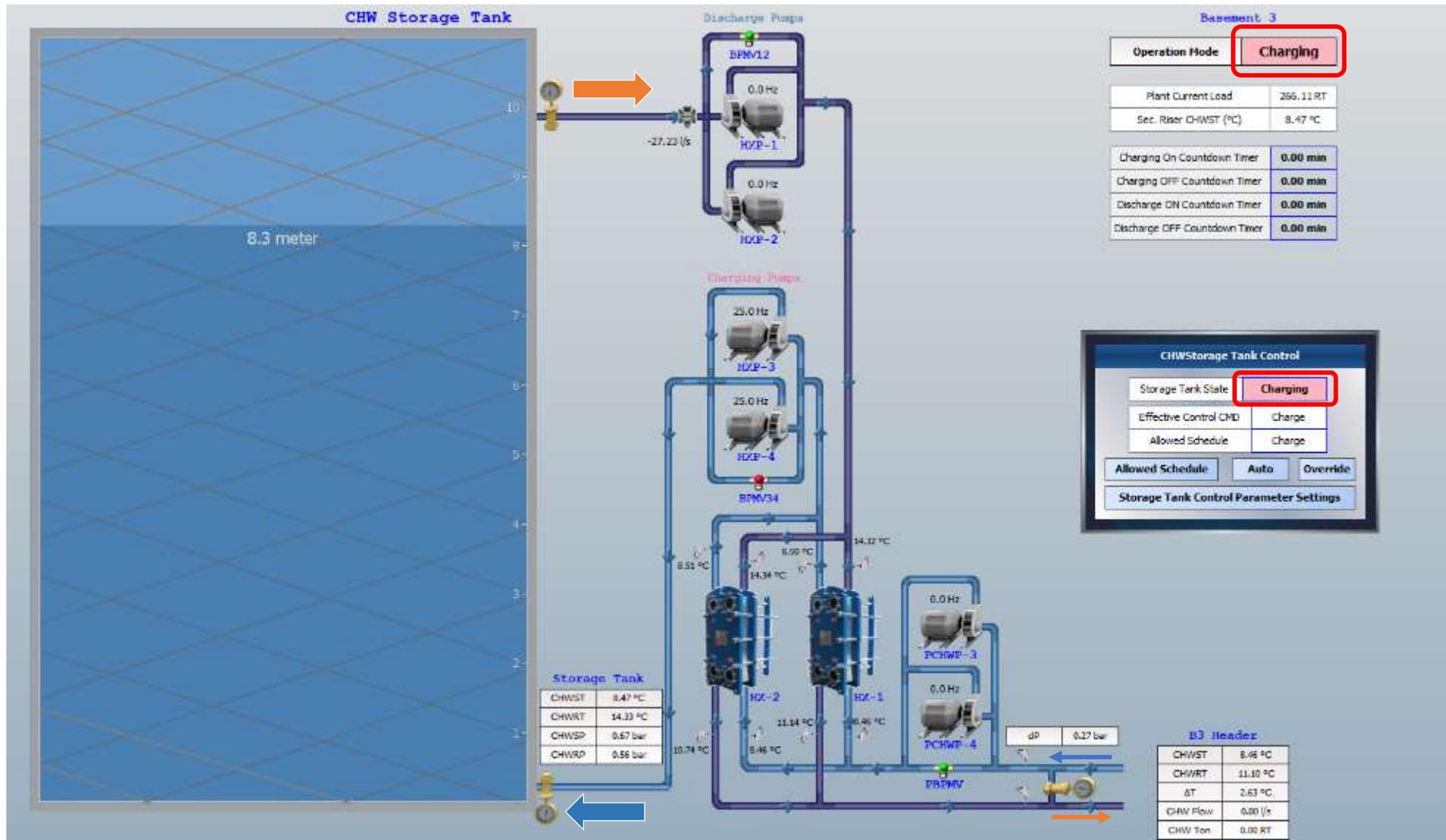
% of Heat Balance Sampling Data within ±5%	
% of Daily Sampling Data within ±5%	96.4 %
% of Weekly Sampling Data within ±5%	92.9 %

Chiller Plant System Heat Balance	
Chiller kW (Electrical)	129.3
Chilled Water Ton in kW	957.4

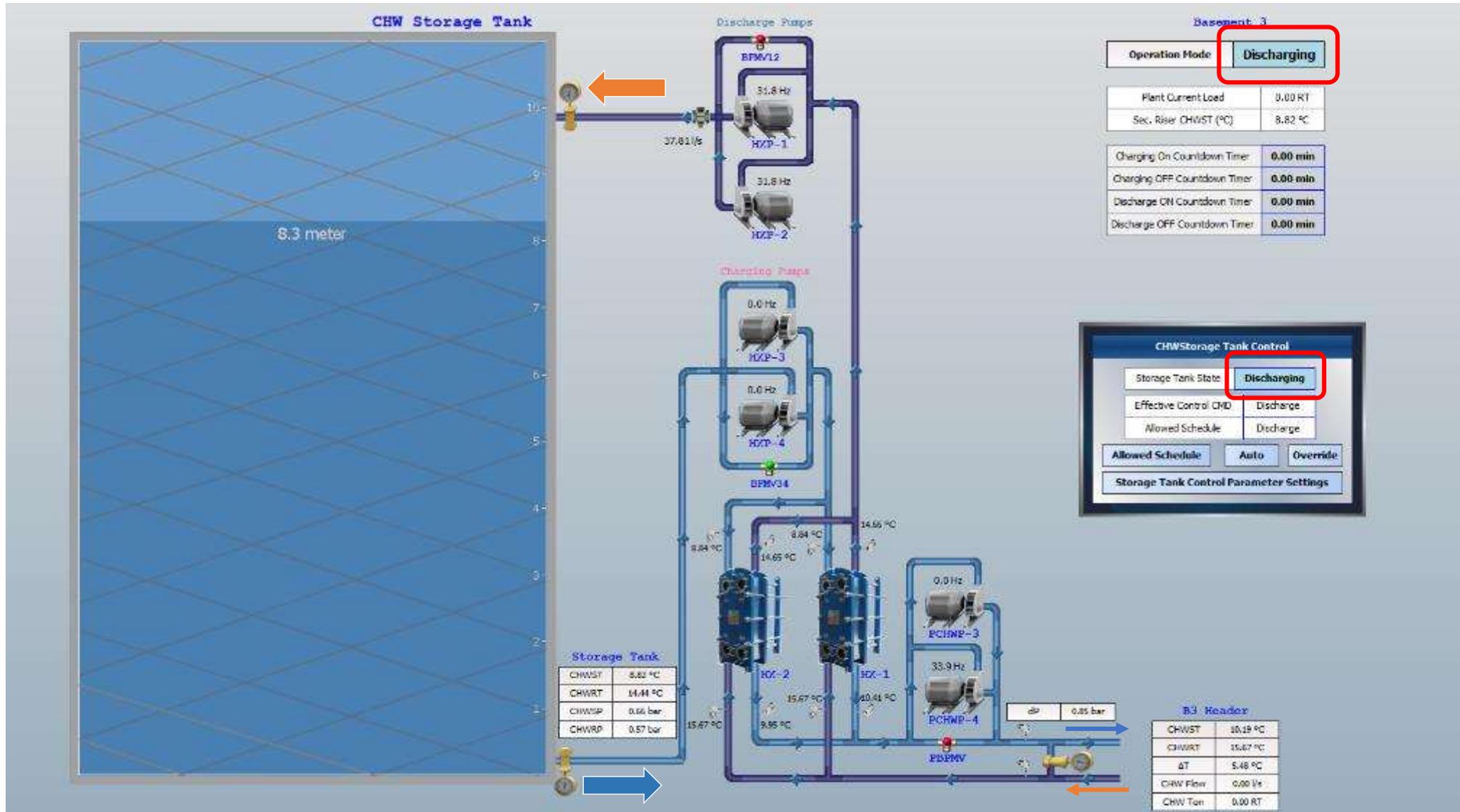
# EEMS Chiller Plant



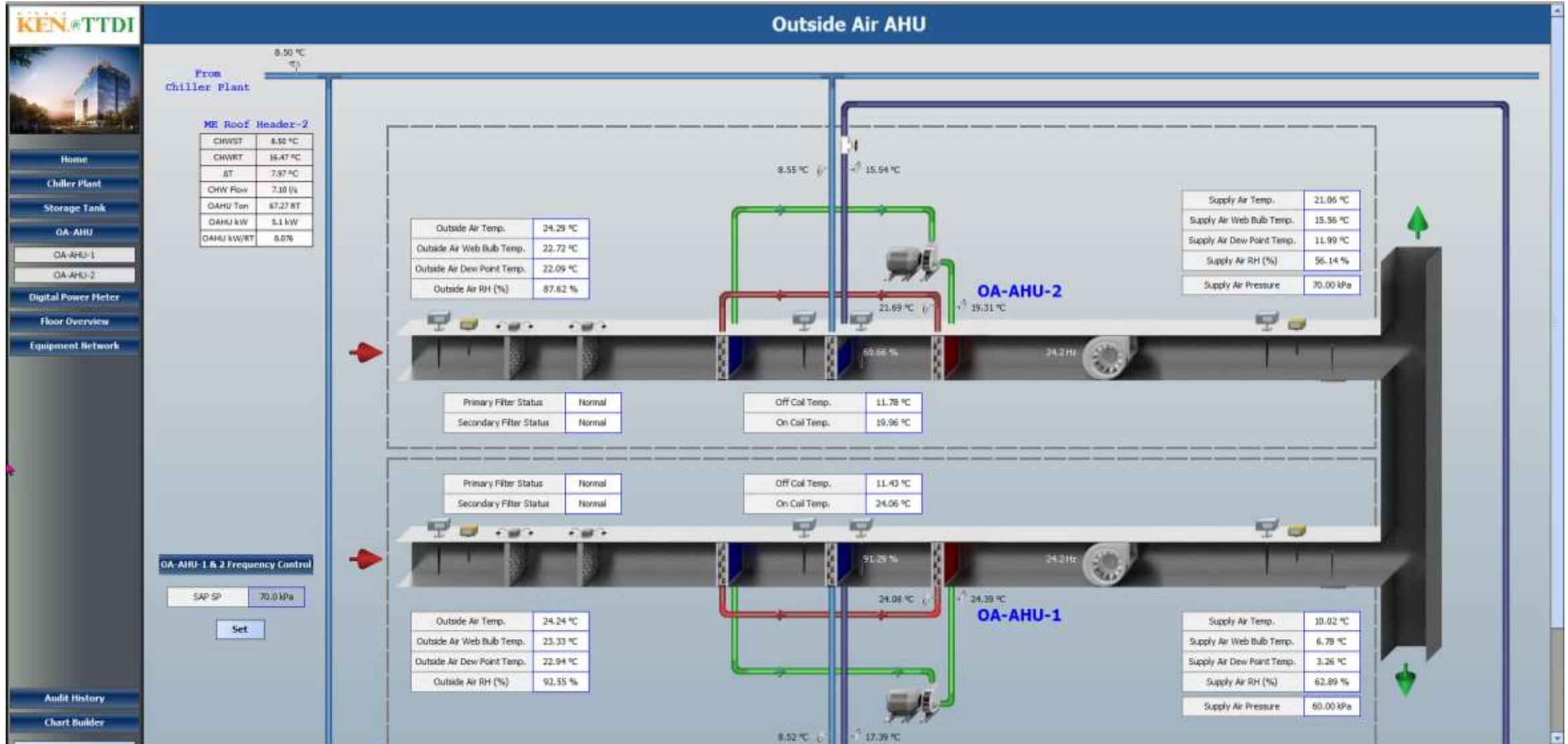
# TES Charging Mode



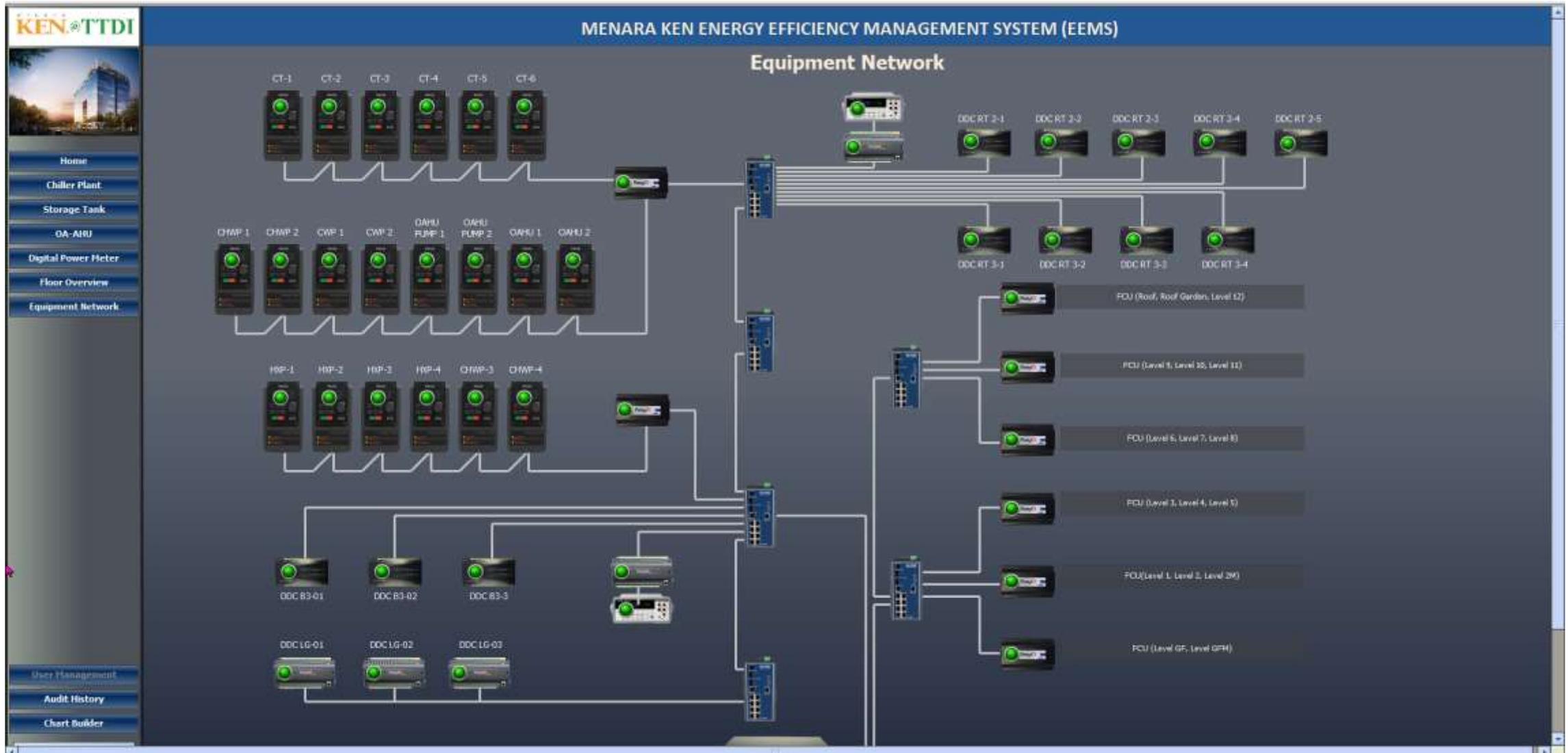
# TES Discharging Mode



# EEMS PAHU Control



# EEMS Network





# Monthly GESP Report

		Monthly total	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22
Cool	Ch. Plant	RTh	82,183	82,034	94,525	123,425	122,266	126,498	112,619	102,015	125,400	123,088	141,603	133,003
	Airside		80,719	80,552	98,235	122,639	100,252	123,734	115,091	102,717	124,161	121,071	140,135	129,794
Electrical	Chiller	kWh	39,510	39,898	45,921	59,368	58,208	61,734	59,876	49,590	61,365	60,267	69,053	64,298
	CHW Pump		8,061	7,701	5,717	7,399	7,160	5,317	5,270	3,882	4,271	4,093	4,345	4,408
	CW Pump		2,861	2,871	3,255	4,192	4,026	4,865	3,877	3,083	3,654	3,541	3,917	3,711
	C. Tower		1,861	1,835	1,737	2,204	2,289	2,400	2,306	1,951	2,256	2,190	2,340	2,280
	Ch. Plant		52,292	52,305	56,630	73,163	71,683	74,316	71,330	58,506	71,546	70,092	79,655	74,696
	Airside		7,894	7,750	10,077	14,001	13,161	14,974	13,314	10,716	11,575	12,288	14,835	15,509
Efficiency	Chiller	kW/RT	0.481	0.486	0.486	0.481	0.476	0.488	0.532	0.486	0.489	0.490	0.488	0.483
	CHW Pump		0.098	0.094	0.060	0.060	0.059	0.042	0.047	0.038	0.034	0.033	0.031	0.033
	CW Pump		0.035	0.035	0.034	0.034	0.033	0.038	0.034	0.030	0.029	0.029	0.028	0.028
	C. Tower		0.023	0.022	0.018	0.018	0.019	0.019	0.020	0.019	0.018	0.018	0.017	0.017
	Ch. Plant		0.636	0.638	0.599	0.593	0.586	0.587	0.633	0.574	0.571	0.569	0.563	0.562
	Airside		0.098	0.096	0.103	0.114	0.131	0.121	0.116	0.104	0.093	0.101	0.106	0.119
	AC. System		0.734	0.734	0.702	0.707	0.718	0.709	0.749	0.678	0.664	0.671	0.668	0.681
Heat balance	Heat in	kWh	328,548	328,410	378,366	493,453	488,218	506,627	455,956	408,377	502,396	493,169	567,070	532,071
	Heat out		331,131	331,609	381,712	493,574	487,884	503,862	450,537	407,133	504,272	492,112	566,976	532,003
	Total count		44,640	44,640	44,640	44,640	44,640	44,640	44,640	44,640	44,640	44,640	44,640	44,640
	Zero value	-	-	-	-	-	-	-	-	-	-	-	-	-
	Empty cell	nos.	24,621	24,530	21,778	15,641	16,879	12,405	16,607	19,288	15,935	16,660	15,322	15,707
	Valid count		20,019	20,110	22,862	28,999	27,761	32,235	28,033	25,352	28,705	27,980	29,318	28,933
	Above 5%		491	525	755	1,152	757	1,023	1,076	1,115	1,073	936	724	654
	Below -5%		1,155	1,242	1,690	1,027	1,234	1,089	1,399	1,353	1,753	1,398	1,128	990
	Within ±5%		18,373	18,343	20,417	26,820	25,770	30,123	25,558	22,884	25,879	25,646	27,466	27,289
Heat balance	%	91.78	91.21	89.31	92.49	92.83	93.45	91.17	90.27	90.16	91.66	93.68	94.32	

Ave 0.67 kW/RT after pandemic

Table 1: Monthly Cooling & Efficiency Record.

# Year 2022 System Performance

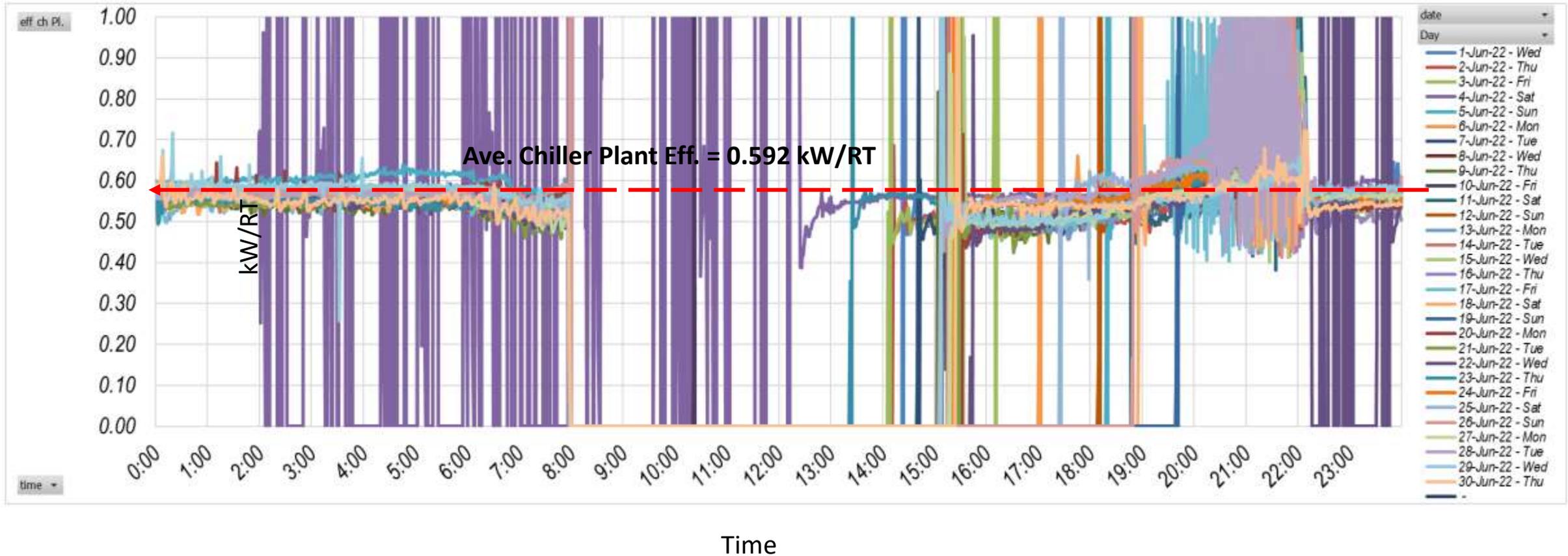


Figure 1: Measured Chiller Plant Efficiency, kW/RT.

# Year 2022 System Performance

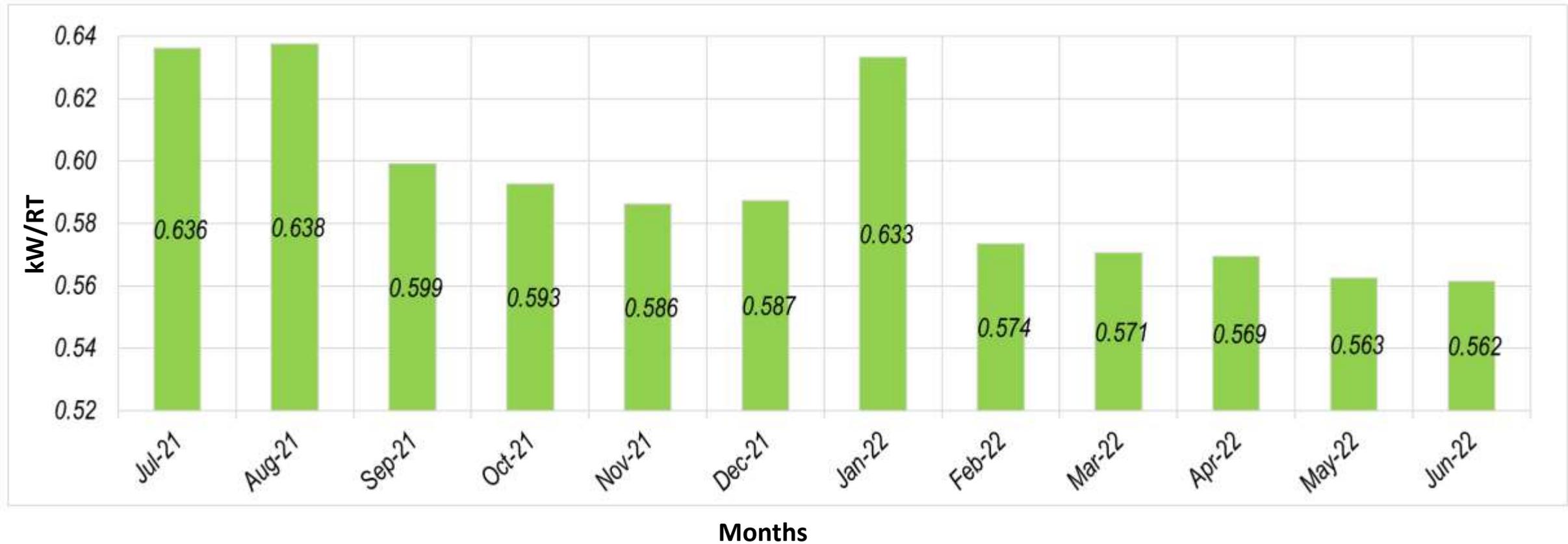


Figure 1: Measured Chiller Plant Efficiency, kW/RT.

# Year 2022 System Performance – Airside Efficiency

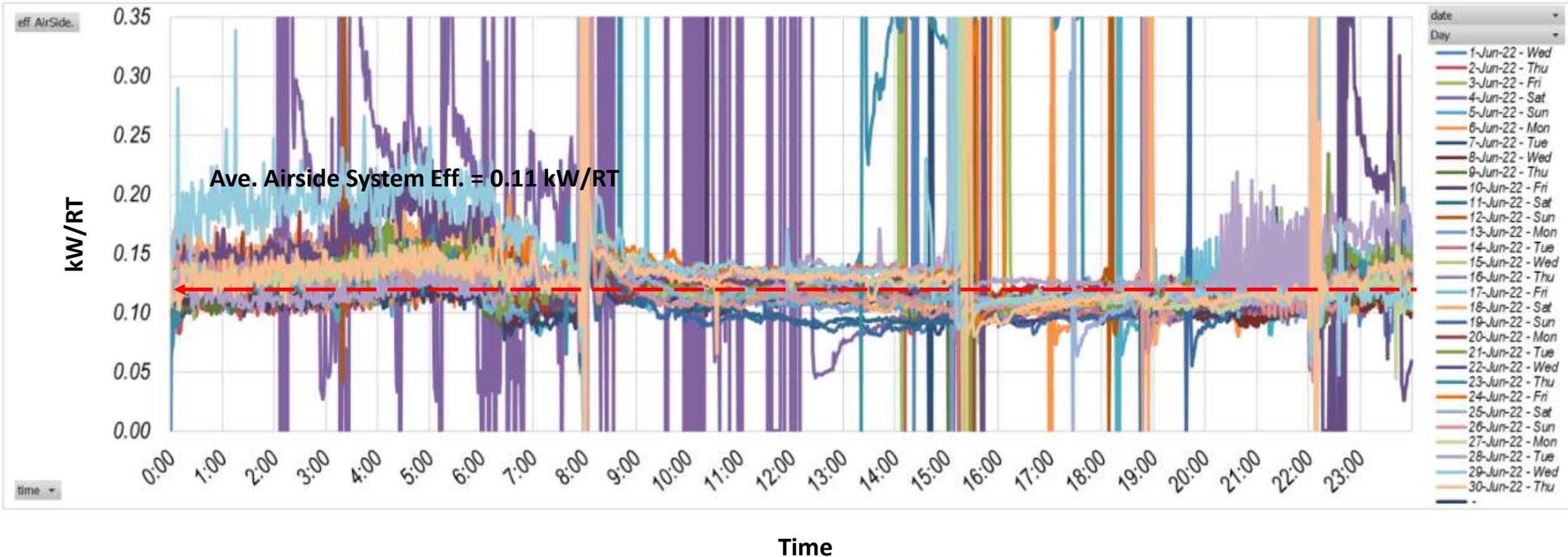


Figure 2: Measured Airside Efficiency, kW/RT.

# Year 2022 System Performance – Airside Efficiency

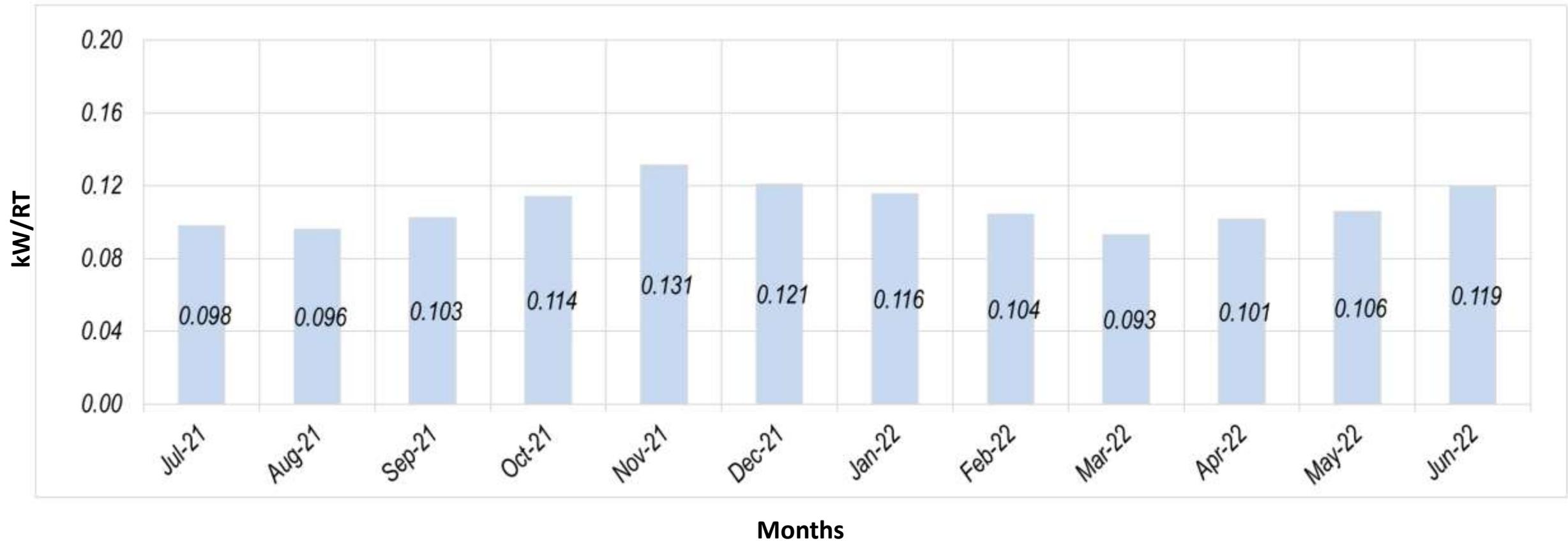


Figure 2: Measured Airside Efficiency, kW/RT.

# Year 2022 System Performance

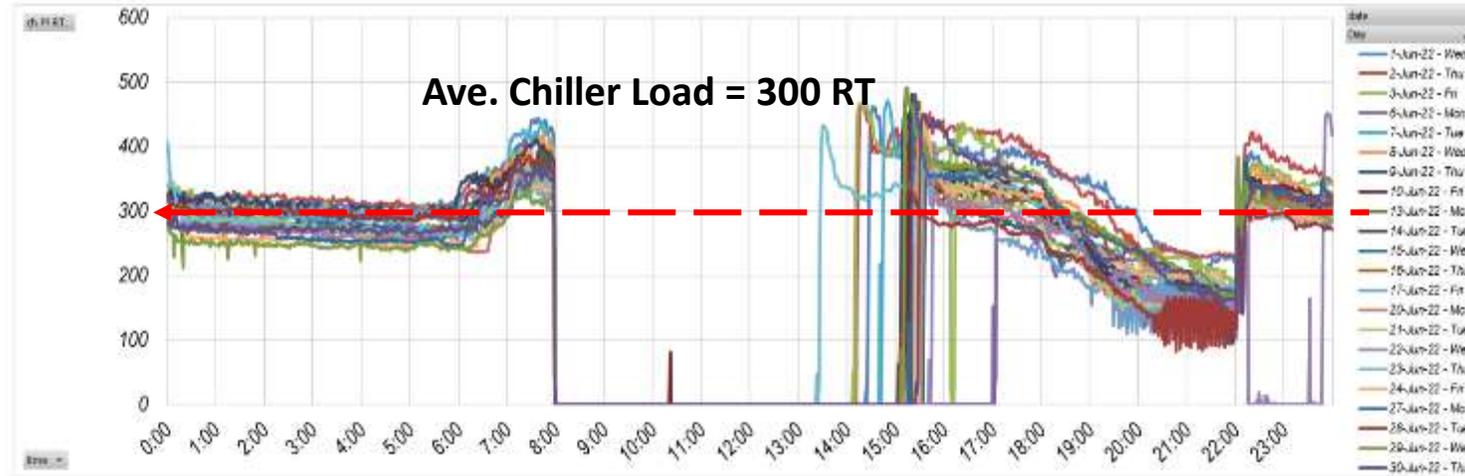


Figure 4: Mon-Fri Cooling Load Profile, RT.

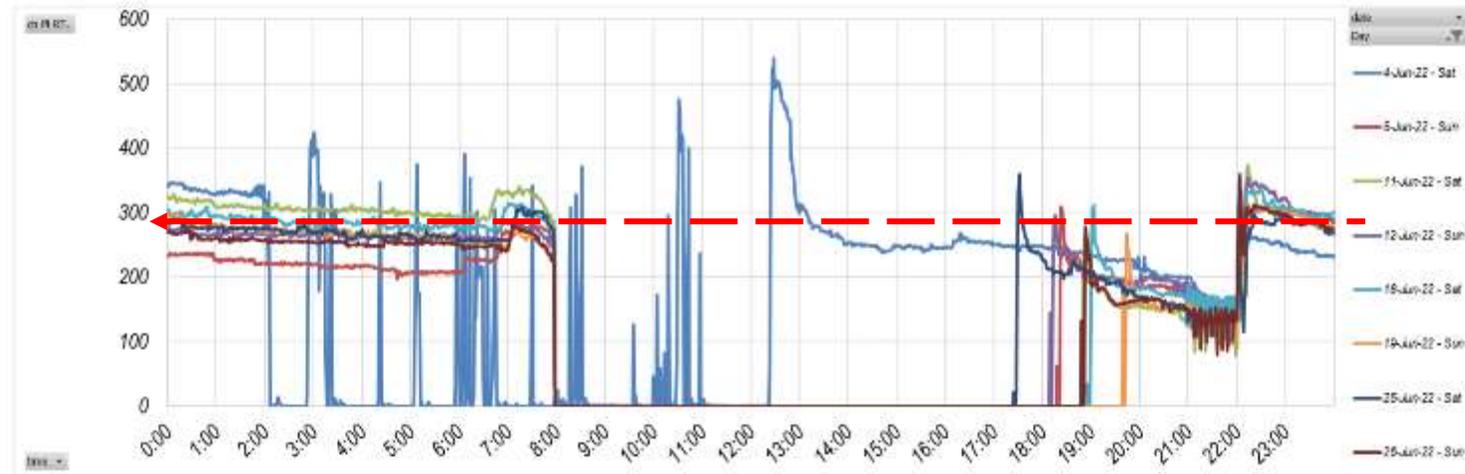


Figure 5: Sat-Sun Cooling Load Profile, RT.

# Year 2022 System Performance

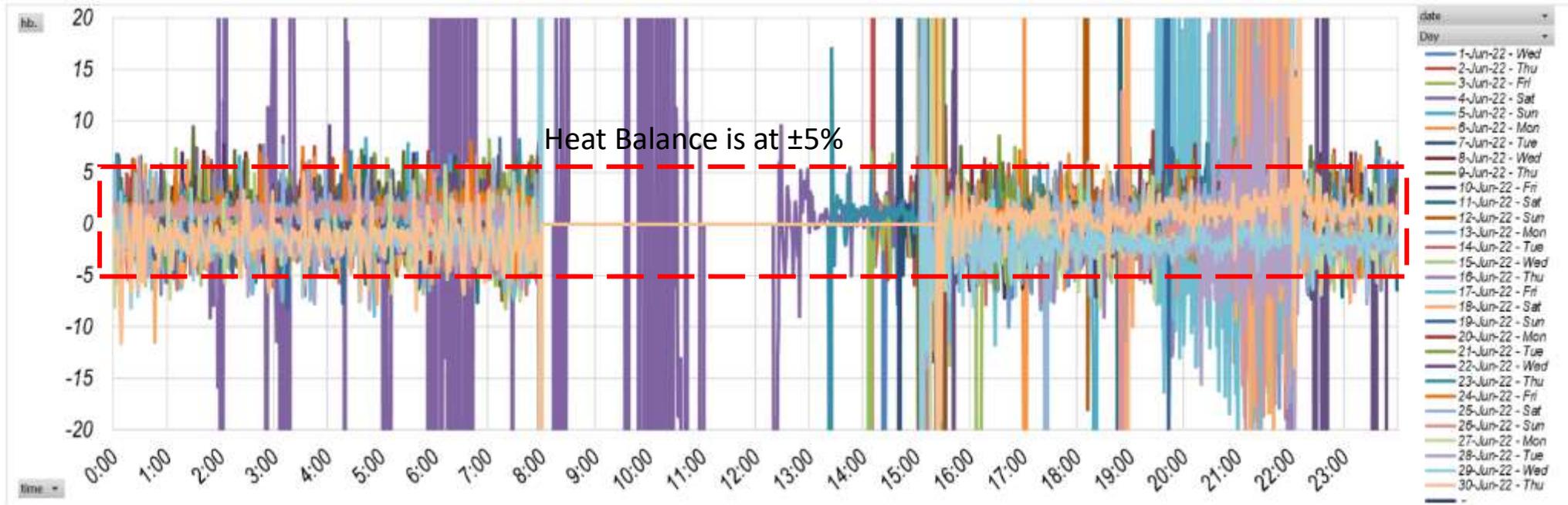
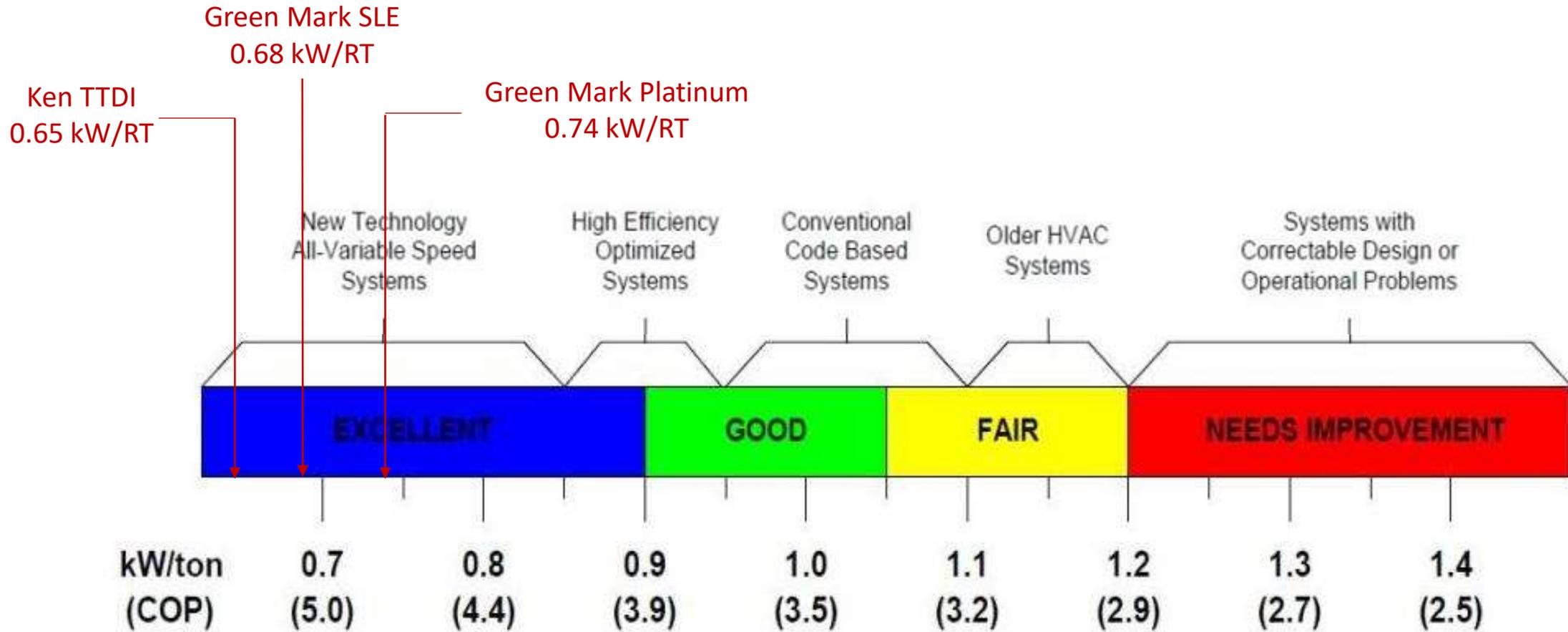


Figure 8: Heat Balance, %.



# Total System Efficiency Benchmark (Chiller Plant + Airside)

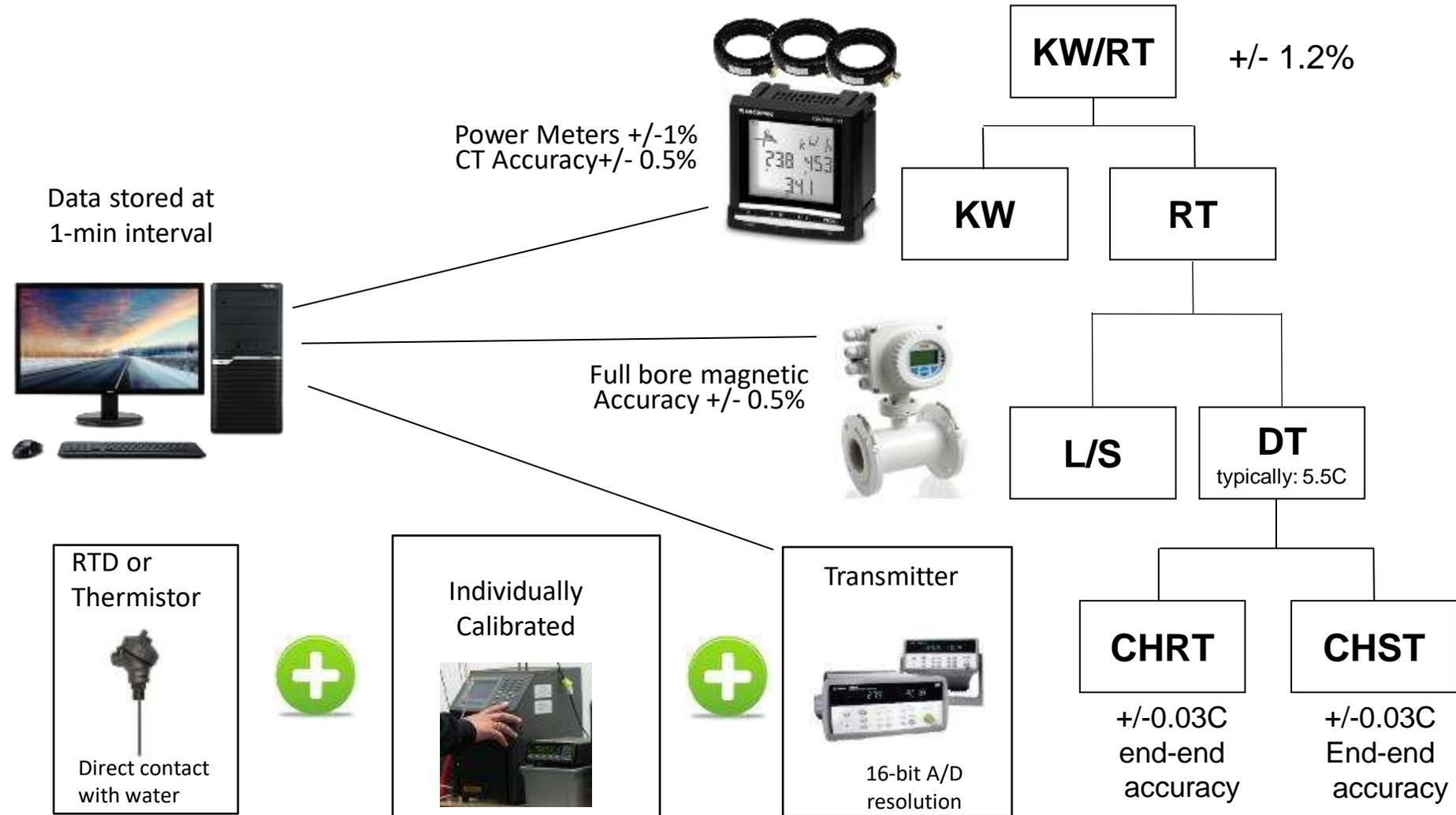


Ashrae  
Journal by  
Thomas  
Hartman

**AVERAGE ANNUAL HVAC EFFICIENCY IN KW/TON**  
(Input energy includes all chillers, chilled water pumps, condenser water pumps, cooling tower fans, supply and return air-handler fans, and exhaust fans)



# Post Project Completion System Performance – High Accuracy Instruments.



# Agenda

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- Building Information
- ACMV System Design Configuration.
- Post Project Completion System Performance.
- **Project Benefits.**



# Project Benefits



## **Benefits to Menara KEN TTDI:**

1. Achieve outstanding energy efficiency of 0.65 kW/RT for the total air conditioning system Efficiency leading to lower operating cost.
2. Won multiple green awards such as National Energy Award, Asean Energy Award, GreenRE, Green Mark and LEED platinum award.
3. Provide 24 x 7 individual controlled air conditioning system.
4. Fully automated ACMV System making it easier for Menara KEN TTDI technicians to monitor and operate the entire system.
5. TES take advantage of lower electricity tariff rate at night to produce chilled water and use the chilled water from the storage during daytime.

Thank you for your  
attention

Discussion and Q&A

