

TAJ PALACE, NEW DELHI

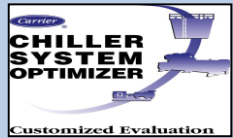


“CHILLER PLANT OPTIMIZATION CASE STUDY”

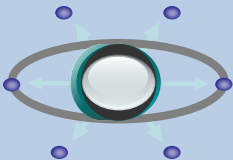
DRIVERS



To Minimize operating cost, to retain business in competitive market.



Upgrade existing system with latest technologies and futuristic in design.



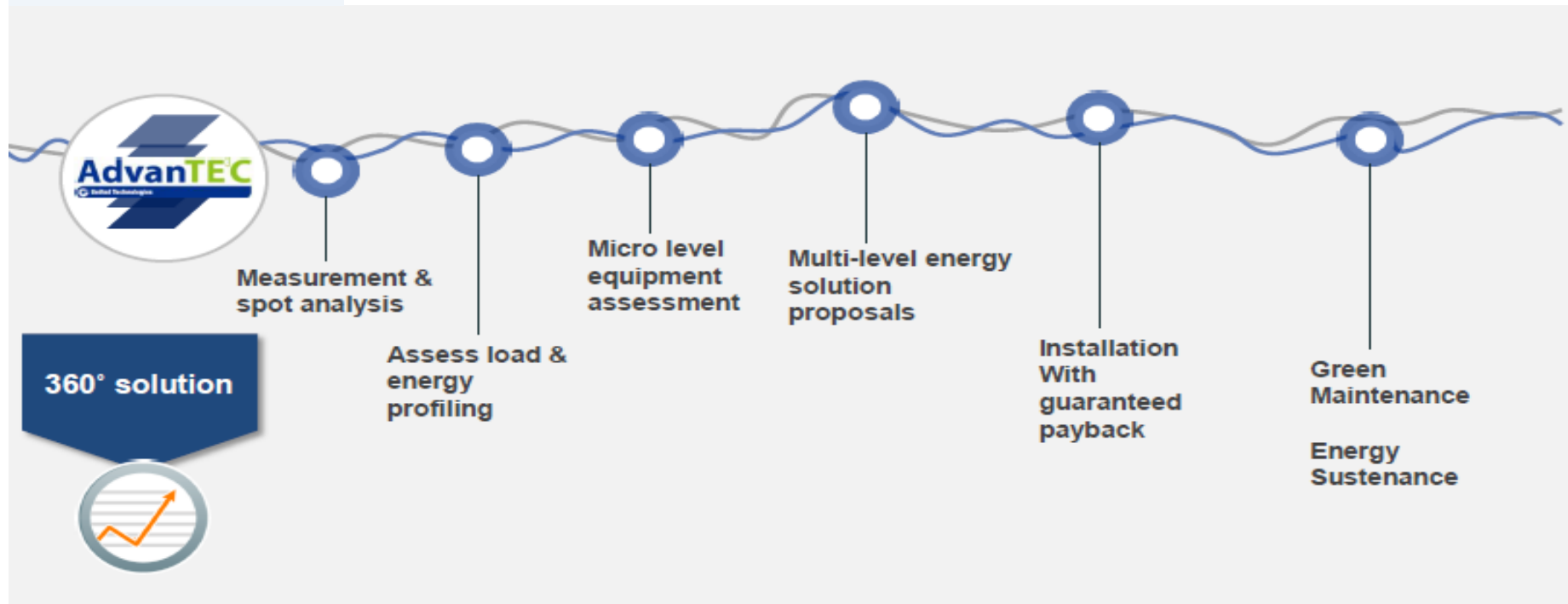
Best/optimum performance at plant system level to comply with global standards.



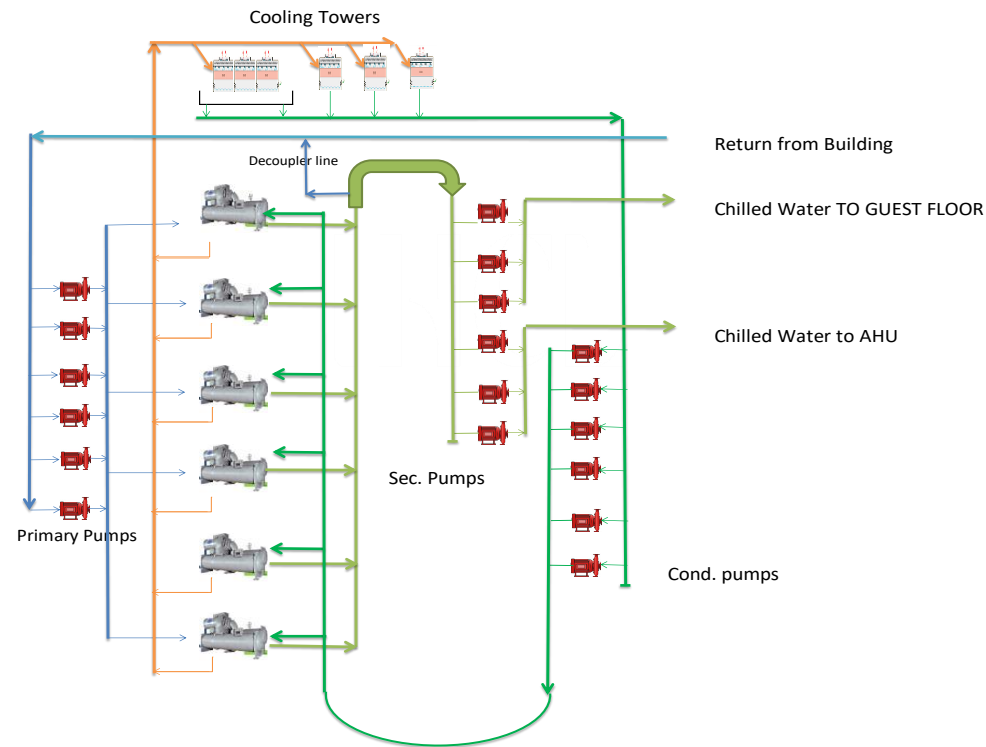
Environmental safety, government regulatory and reduction in carbon foot print.

METHODOLOGY

Chiller Plant Audit



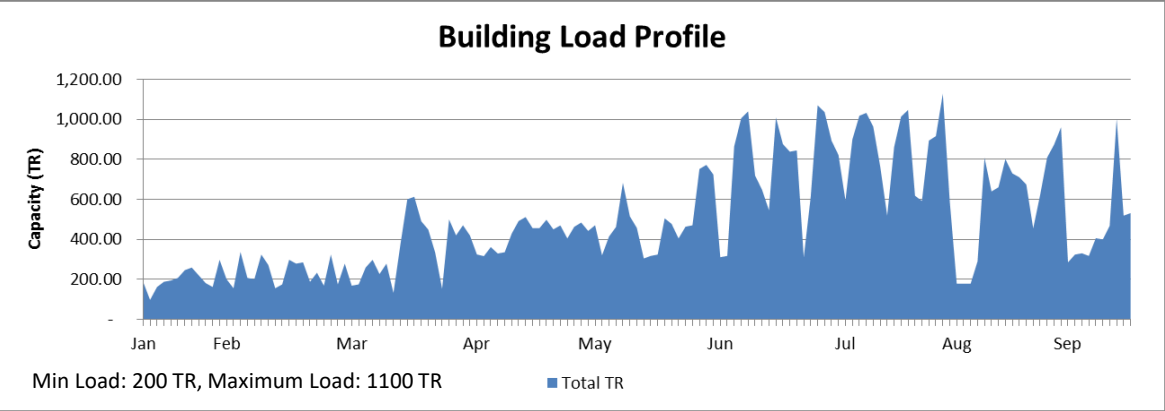
ORIGINAL STATE



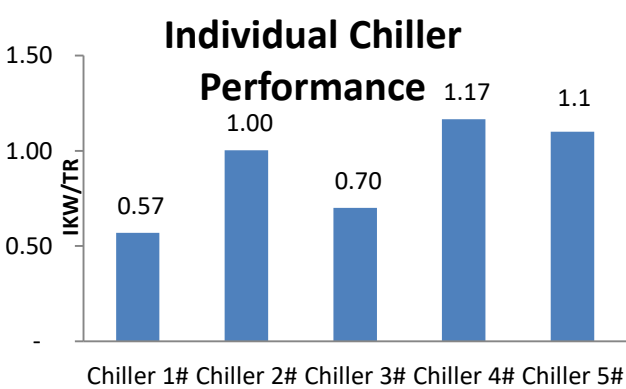
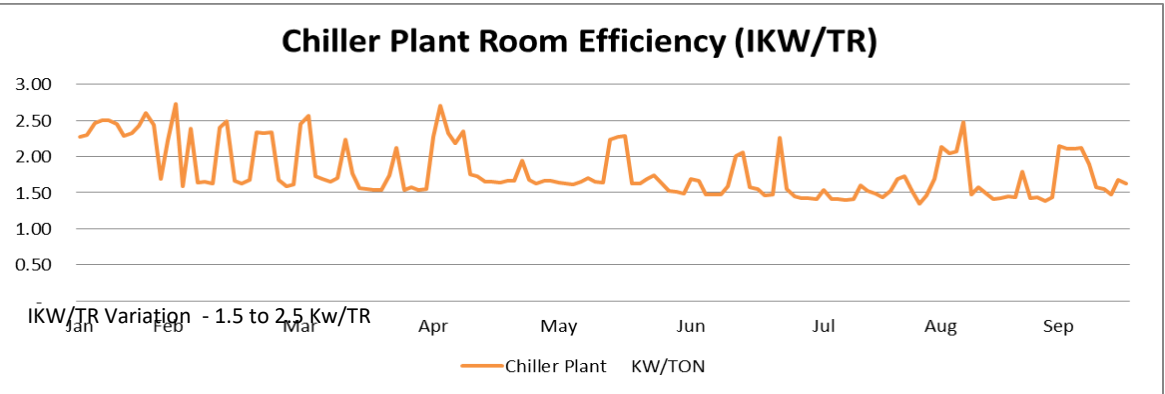
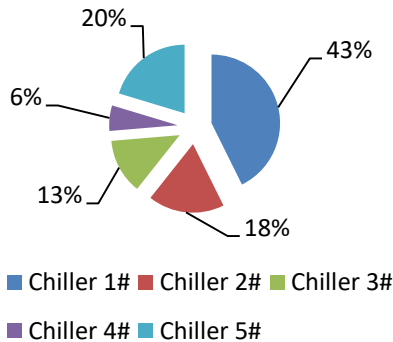
Plant Room Configuration

BUILDING COVERED AREA:	54114.52	Sq. Mtr.
AIRCONDITIONED AREA:	42102.59	Sq. Mtr.
PLANT ROOM CAPACITY:	2139	TR
No of Chillers:	6 Nos (Installed in Phased Manner)	
Type of chillers:	Multi compressor	
W/C Screw		
Pumping System:	Dedicated	
Primary,		
secondary side	2 zones on	
point	Different duty	
Cooling Tower:	6 Nos Cooling	
Tower		
Controls and Monitoring:	Not Installed.	

AUDIT FINDINGS



Chiller Running Profile



Chiller Efficiency Test



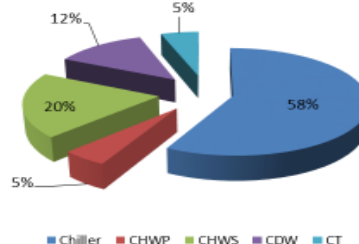
Date of Reading	Chiller Tag No.	Time	Design Capacity (TR)	CHW In Temp. (°C)	CHW Out Temp. (°C)	CHW Flow Rate (LPS)	Actual Capacity (TR)	Input Current (A)	Avg. Voltage (V)	Avg. Power Factor	% Motor Current	Input KW	Chiller (KW/TR)	Auxiliary Equipment (KW)	Plant Room (KW/TR)
24/9/2013	1	10:45	300	13.7	8.7	5	54	328	305	408	0.87	100%	100	0.58	
24/9/2013	2	10:45	300	17.8	13.5	4.3	75	309	341	396	0.87	97%	203	0.53	
24/9/2013	3	10:45	300	13.9	11.7	2.2	54	142	225	396	0.87	64%	134	0.94	
24/9/2013	4	10:45	300	13.3	11.8	1.5	49	89	179	396	0.87	50%	100	1.15	
24/9/2013	5	10:45	300	11.7	9.3	2.4	58	167	336	396	0.87	100%	200	1.20	
11:00															
24/9/2013	1	11:45	300	14.3	9	5.3	54	344	307	413	0.857	100%	199	0.55	
24/9/2013	2	11:45	300	19.1	14.7	4.4	75	304	343	396	0.857	100%	202	0.51	
24/9/2013	3	11:45	300	14.2	11.5	2.7	54	174	225	413	0.857	64%	130	0.79	
24/9/2013	4	11:45	300	13.6	12	1.5	49	88	175.2	413	0.853	50%	107	1.22	
24/9/2013	5	11:45	300	12	9.6	2.4	58	167	341	413	0.857	100%	209	1.25	
11:55															
24/9/2013	1	12:45	300	14.1	9	5.1	54	371	308	414	0.856	100%	199	0.57	
24/9/2013	2	12:45	300	18.8	14.9	3.9	75	349	365	396	0.856	100%	210	0.62	
24/9/2013	3	12:45	300	14.6	18.3	4.3	54	279	331	396	0.856	96%	194	0.70	
24/9/2013	5	12:45	300	11.7	9.3	2.4	58	167	315	414	0.856	90%	199	1.16	
13:00															
24/9/2013	1	13:45	300	14	8.9	5.1	54	371	307	411	0.85	100%	198	0.56	
24/9/2013	2	13:45	300	18.7	15.1	3.6	75	362	351	396	0.85	100%	204	0.63	
24/9/2013	3	13:45	300	14.4	11.5	2.9	54	187	225	411	0.85	64%	130	0.73	
24/9/2013	4	13:45	300	13.6	12.1	1.5	49	88	175.2	411	0.85	50%	104	1.19	
24/9/2013	5	13:45	300	11.8	9.6	2.2	58	163	339	411	0.85	100%	205	1.34	
13:55															
24/9/2013	1	14:45	300	14.3	9	5.3	54	344	307	413	0.87	100%	199	0.55	
24/9/2013	2	14:45	300	18.3	14.8	3.5	75	371	363	396	0.87	100%	212	0.64	
24/9/2013	3	14:45	300	14.6	11.5	3	54	194	224	413	0.87	65%	130	0.72	
24/9/2013	4	14:45	300	13.1	12.1	1	49	69	171	413	0.87	50%	106	1.82	
24/9/2013	5	14:45	300	11.8	9.1	2.7	58	189	367	413	0.87	100%	228	1.22	
14:55															
														351.2	1.13

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Chiller Plant Efficiency According to Operation Log



AC Plant Power Consumption



Energy consumption percentage:

- Chiller: 58%
- P. Chilled Water Pump: 5%
- S. Chilled Water Pump: 20%
- Condenser water pump: 12%
- Cooling Tower: 5%

Plant Room average efficiency:

- Ancillaries power consumption is higher than the trend.
- Secondary chilled water pumps are equipped with VFD but Drives are not in auto mode Hence consuming more power.
- Ancillaries optimization is required to improve the plant room efficiency.

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Condenser Pump Performance Check



- Spot readings taken for chilled water pumps
- Pump Head and Flow Rate tested
- Power consumption also tested

Condenser Water Pump															
Date of Reading	Time (Hrs)	Pump No.	Pump Make	Pump Model	Pump Name Plate Data			Actual Site Data							
					(Q M /hr)	d (m)	RPM	Motor KW	Press. (psig)	Press. (psig)	Head (M)	(c.m.s./ hr)	Current (A)	Voltage (V)	Power Factor
29/09/2013	13:00	1	Grundfos	NK 150-315	279	29	1450	30.0			0.0	47.7	403	0.87	29
29/09/2013	13:00	2	Grundfos	NK 150-315	279	29	1450	30.0				47.7	403	0.87	29
29/09/2013	13:00	3	Grundfos	NK 150-315	279	29	1450	30.0				41.5	403	0.87	25
29/09/2013	13:00	4	Grundfos	NK 150-315	279	29	1450	30.0			0.0	47	403	0.87	28
29/09/2013	13:00	5	Grundfos	NK 150-315					Under BD / Pump Not available						
29/09/2013	13:00	6	Grundfos	NK 150-315	279	29	1450	30.0			0.0	46.4	403	0.87	28

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Cooling Tower Performance Check



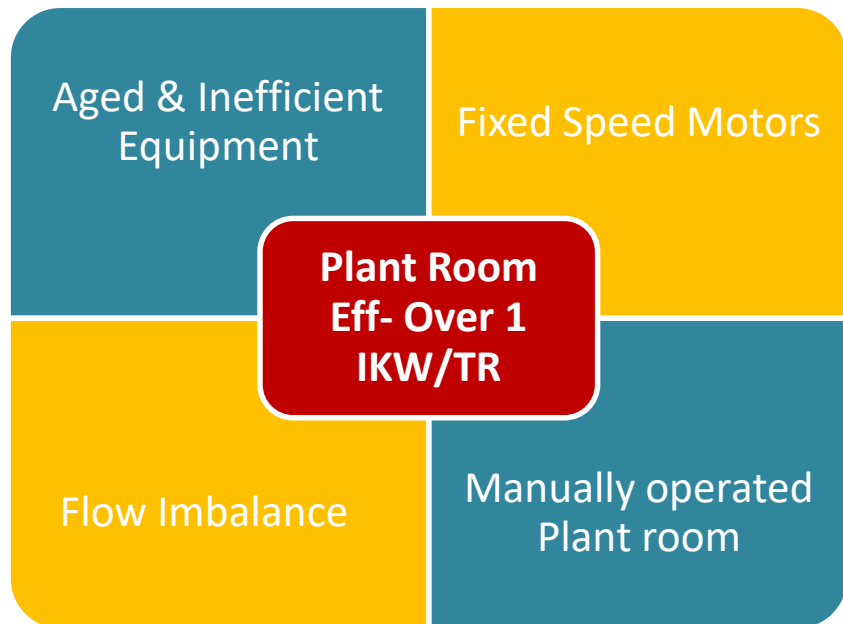
- Spot readings taken for cooling towers
- Cooling Tower Approach Calculation

Cooling tower approach is very high

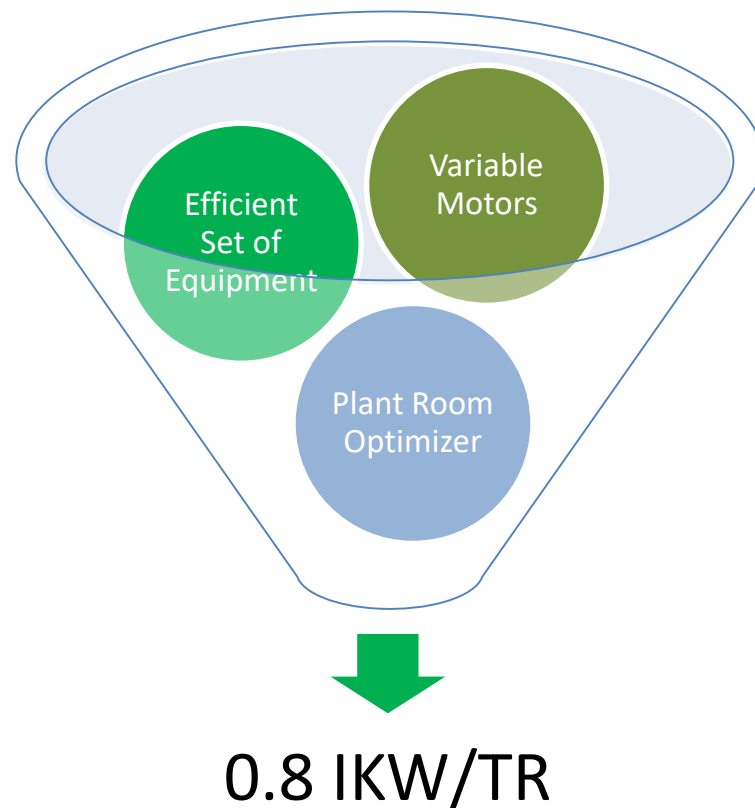
COOLING TOWER DATA															
Date of Reading	Time (Hrs)	Cooling Tower Make	Actual Site Data												
			CT 1	CT 2	CT 3	Avg. Current (A)	Voltage (V)	Power Factor	Motor KW	O/A DBT (°F)	O/A WBTT (°F)	Wm Temp (°F)	Wdht. Temp (°F)	Remarks	
24/09/2013	12:45	Pakbayat Make Cooling Tower, 03 nos.	22	17	17	56.4	403	0.87	34.2	89.6	69%	77	89.6	88.52	11.5
24/09/2013	12:45	Pakbayat Make Cooling Tower, 01 nos.				20.0	403	0.87	12.3	89.6	69%	77	89.6	89.24	12.3
24/09/2013	12:45	Pakbayat Make Cooling Tower, 01 nos.				19.0	403	0.87	11.5	89.6	69%	77	89.6	88.74	11.5

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FINDINGS



RECOMMENDATIONS



INTERVENTIONS UNDERTAKEN

Equipment

- High Efficient Chiller
- New Variable Pumps
- CTI certified Cooling Tower
- Anti Fouling Devices on heat exchanger

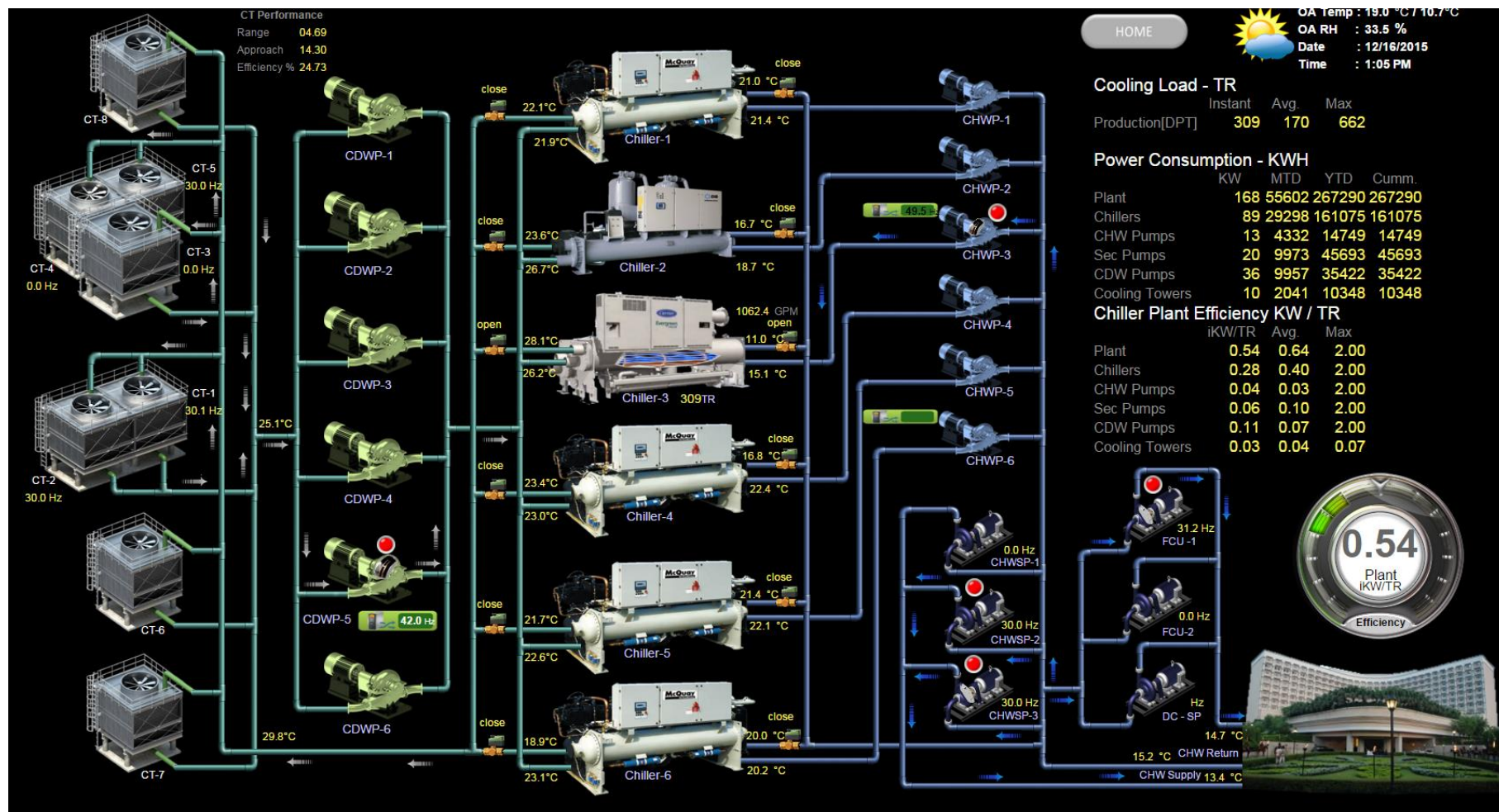
System Level

- Dedicated Pumping for Zero Bypass/Leakage
- All Variable system design to sustain plant performance
- System Designed for < 0.8 IKW/Tr Performance


Integration

- Chiller Plant optimizer
- Real Time data logging
- Advance Remote monitoring
- Adaptive Algorithms for continuous performance improvement

SNAPSHOT OF PLANT OPTIMIZER DASHBOARD



SNAPSHOT OF PLANT OPTIMIZER DASHBOARD


OA Temp : 19.0 °C / 10.6 °C
OA RH : 33.0 %
Date : 12/16/2015
Time : 1:05 PM



Plant iKW/TR 0.54

Equipments Running KW

Chillers	1	87
CHWP Pumps	1	13
CHWSP Pumps	3	21
CDWP Pumps	1	36
Cooling Towers	3	10

Plant KW 167.61 KW

Plant TR 332.51 TR



Chiller Parameter

Chiller Parameter	Chiller -1	Chiller -3	Chiller -6
Run status	OFF	ON	OFF
Setpoint Point (°C)	12.00	12.00	12.00
Suction pressure (kPa)	513.00	337.50	495.00
Discharge pressure (kPa)	515.00	654.00	536.00
Entering chilled water temp (°C)	21.40	15.00	20.20
Leaving chilled water temp (°C)	21.10	11.90	20.00
Evaporator Approach (°C)	-2.50	0.45	-1.30
Entering condenser water temp (°C)	21.90	26.10	21.60
Leaving condenser water temp (°C)	22.10	28.30	22.20
Condenser Approach (°C)	0.40	0.92	1.30
Chiller TR	0.00	251.11	0.00
Average Line Voltage (Volts)	420.81	419.50	421.68
Average Line Current (Amps)	1.68	134.30	1.65
Motor Kilowatt (kW)	0.96	88.00	0.96
Chiller iKW/TR	0.00	0.35	0.00

HOME

PLANT ROOM

CHW SYSTEM

CDW SYSTEM

CHILLERS

Energy Meters

VFD

Data logger

AdvanTEC

Diagnostic Console

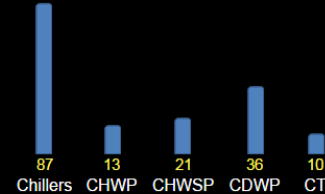
CDW Supply Temp 25.00 °C
 CDW Return Temp 29.70 °C

SEC Supply Temp-AHU 13.40 °C
 SEC Supply Temp-FCU 14.70 °C
 SEC Return Temp 15.20 °C

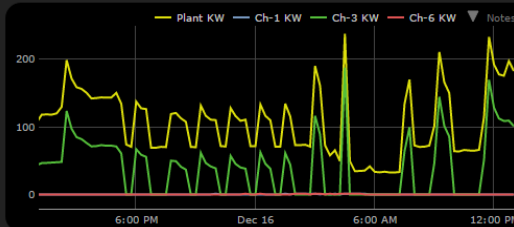
Cooling Tower Efficiency 24.87 %
 Cooling Tower Approach 14.20 °C

CHWS Setpoint USER 12.0 °C

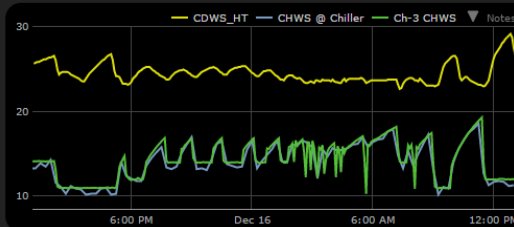
Current Power Consumption



Dignostic - KW



Dignostic - Temp



Description	A / M	KW
CHWP-1	AUTO	0.0
CHWP-2	MANUAL	0.0
CHWP-3	AUTO	13.0
CHWP-4	MANUAL	0.0
CHWP-5	MANUAL	0.0
CHWP-6	AUTO	0.0

Description	A / M	KW
CHWSP-1	AUTO	0.0
CHWSP-2	AUTO	6.5
CHWSP-3	AUTO	7.3
CHWSP-4	AUTO	7.2
CHWSP-5	AUTO	0.0

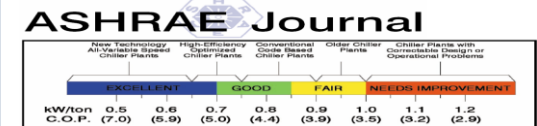
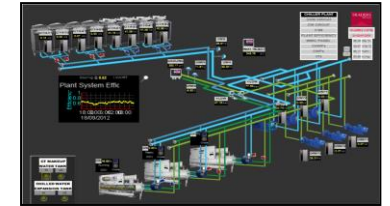
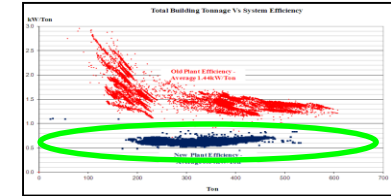
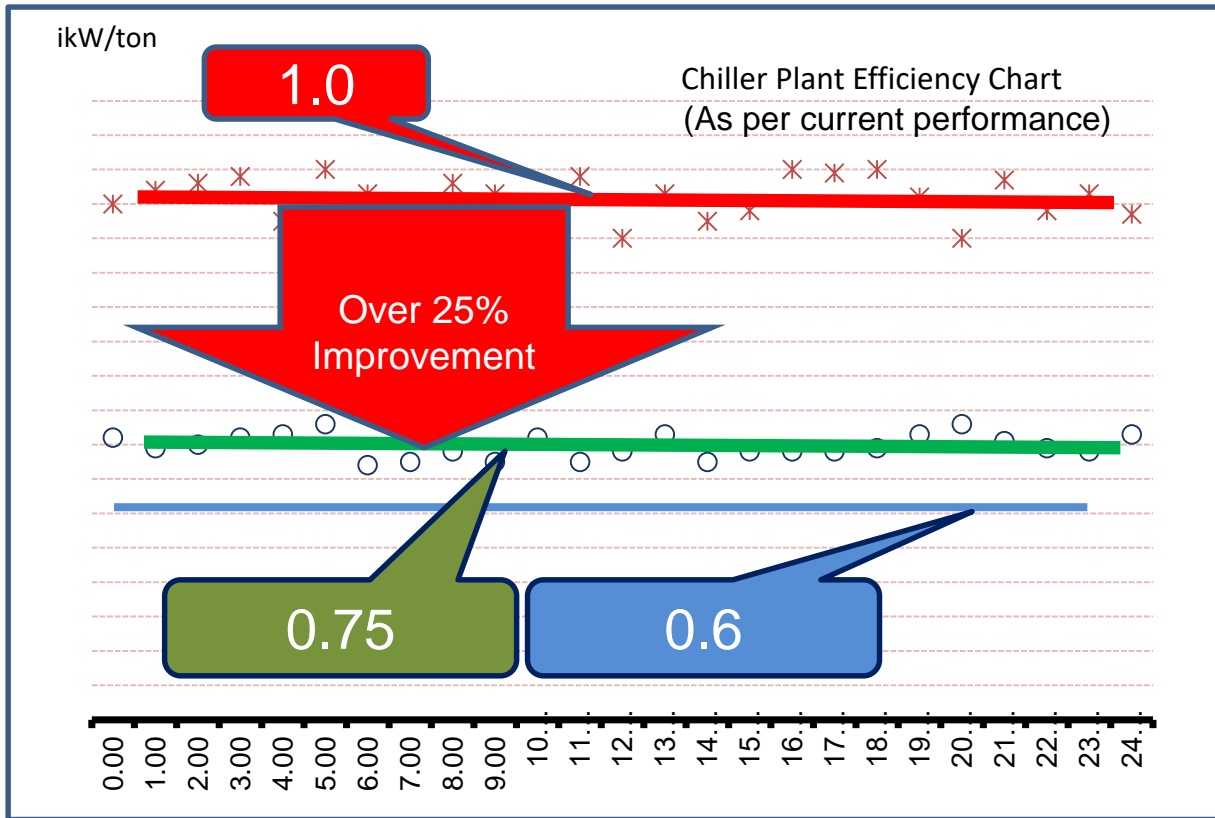
Description	A / M	KW
CDWP-1	AUTO	0.0
CDWP-2	AUTO	0.0
CDWP-3	MANUAL	0.0
CDWP-4	MANUAL	0.0
CDWP-5	AUTO	36.5
CDWP-6	MANUAL	0.0

Description	A / M	KW
CT-1	AUTO	3.1
CT-2	AUTO	3.5
CT-3	AUTO	0.0
CT-4	AUTO	0.0
CT-5	AUTO	3.3

SNAPSHOT OF PLANT OPTIMIZER DASHBOARD



ENERGY SAVINGS ACHIEVED



0.64

Target 0.65

25% Improvement!

1.44

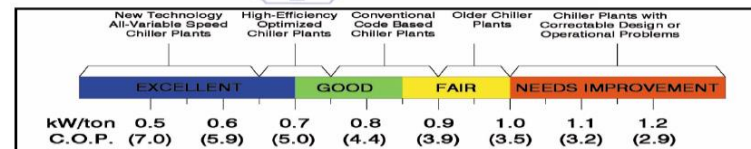
M&V - ENERGY SAVINGS

MONTH	POWER CONSUMPTION - KWH			
	2014	2015 - 16	2016 - 17	2017 - 18
JUL	595,112	399,633	468,819	493,815
AUG	614,831	422,286	450,106	485,404
SEP	485,122	366,677	408,369	405,936
OCT	353,501	267,137	182,230	275,466
NOV	219,851	139,851		
DEC	191,457			
JAN	144,293	105,271		73,112
FEB	132,784	155,250	98,788	120,861
MAR	256,133	171,517	181,192	183,414
APR	314,301	256,183	290,185	266,598
MAY	456,617	367,412	350,736	349,545
JUN	522,424	438,822	416,484	423,267
	4232653	3206698	3219138	3308726
	SAVINGS	24%	24%	25%

7% Savings at Building Level Consumption.

MONTH	POWER CONSUMPTION - KWH/TR		
	2015-16	2016-17	2017-18
JUL	0.76	0.73	0.68
AUG	0.73	0.72	0.68
SEP	0.72	0.74	0.68
OCT	0.74	0.72	0.67
NOV	0.77	0.76	0.68
DEC	0.84	0.95	0.74
JAN	1.12	1.07	0.77
FEB	0.74	0.74	0.71
MAR	0.66	0.70	0.62
APR	0.67	0.68	0.65
MAY	0.73	0.68	0.67
JUN	0.88	0.68	0.68
AVERAGE	0.78	0.76	0.69

ASHRAE Journal



National Energy Conservation Award

Energy Conservation Initiatives:

1. Building HVAC system optimization & Revamp



Till 2014, 52-58% of total electrical consumption was from HVAC and in HVAC also 40-45% was contributed by Chillers/Heat machines and its connected accessories like pumps and cooling tower. The Carrier's AdvanTE3C team carried out a detailed Energy Assessment of the entire HVAC system which included studying the building load and energy pattern. On the basis of assessment, new Carrier Heat machine 23XRV 520TR, Plant System Manager with advance controls and other plant room equipment's were introduced into system. AdvanTE3C team did the entire project execution and handed over the project on July 1st, 2015. It resulted in improving the plant room efficiency by 26%, providing a saving in excess of **1000,000KWH** in a span of 9 months. By the end of financial year 2015-16, hotel was able to provide **90 lacs** of monetary saving through electrical unit's consumption reduction. In spite of unavailability of major saving months i.e. April, May, June where HVAC runs on 100% load, 90% of proposed savings were achieved. The system is operated in fully automated mode using the Carrier advance Plant Room System optimization using multiple strategies such as Cooling tower staging, Cooling tower fan speed control, Condenser water pump speed control, secondary water pumps speed control, Chiller staging, chilled water reset etc. The controls system also does the Energy diagnostic of the plant room to identify areas of potential energy waste and provide relevant information on waste avoidance and correction. There was major reduction of electricity generation through Diesel Generator, where 23000 ltrs of HSD consumption was less than year 2014-15.



Thank You

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