ECOVIS
Energy consulting

Energy Efficiency Test report Nr. 2017/10

2017

Intelligent chiller booster, adiabatic pre - cooling system "Smart Cooling™" with air cooled water chillers

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Project location:	UAE, Fujairah, NOVOTEL / IBIS
Test time:	sept 9, 2017 - sept 20, 2017 8 Day study to measure the ability of a air cooled water chiller system to lower KWh consumption of a air cooled chillers, PETRA, model APSa 325-2

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The Test:

Energy consulting

We had tested intelligent adiabatic condensers pre-cooling system 'Smart Cooling™' with air-cooled water chillers. The test was designed & conducted to measure specific KW/h and weather conditions during a 4 consecutive day period with the adiabatic pre-cooling system off versus a 4 consecutive day period with the adiabatic pre-cooling system on. The total KW used during each period will be compared to each other along with weather conditions during each period in order to determine the efficacy of the pre-cooling system to save energy. A 4-day period was chosen so that other factors would be equal. The 4-day periods where run consecutively in order to provide as similar test conditions for each period as possible. The 'Smart Cooling™' equipment was installed and the study was conducted by ECO- VIS ENGENEERING. It was overseen & verified by personnel from AKURA GROUP / NOVOTEL / IBIS HOTELS corporation. The equipment used consisted of adiabatic system 'Smart Cooling™' BY 70. Main components: high pressure water pump, controller with chiller load analyzer, temperature and humidity probe, condensers protection, protecting membranes (condenser pre filters). Water treatment module EMI 2500 with anti-scaling system and UV sterilization UV100, provided water protection from scaling, bacteria as well Legionella.

Petra chiller APSa 325-25

Adiabatic system 'Smart Cooling™' BY-70

Testing procedures:

Step 1	A data logger was installed on the subject HVAC equipment to collect all applicable real-time energy consumption and unit performance information. Data was collected with Enicope analytics, energy measurement. The first 4 days (96 hours of use) of the test measured energy used by the condenser without the aid of 'Smart Cooling™' unit. During this period the condenser consumed 44264 KWh (kilowatt hours) of electricity. Water consumption 0 m3. The average temperature and relative humidity during the period was 36.56° C / 39,9 %RH.
Step 2	Switch ON the 'Smart Cooling™' system.
Step 3	The next 4 days (96 hours of use) of the test measured energy used by the condenser with an intelligent adiabatic system 'Smart Cooling™'. During this period the condenser consumed 34955 KWh (Kilowatt hours) of electricity. Water consumption 69 m3. The average temperature and relative humidity during the period was 36.28° C / 41.32 %RH. After data analysis monitoring numbers showed: Difference / energy savings that 'Smart Cooling™' system provided per 4 working days was 9308 KWh (kilowatt hours) of electricity. In Table No.1 we can see all numbers, used energy consumption kw/h before and after using adiabatic system, air temperature, air humidity, working hours.

Test description:

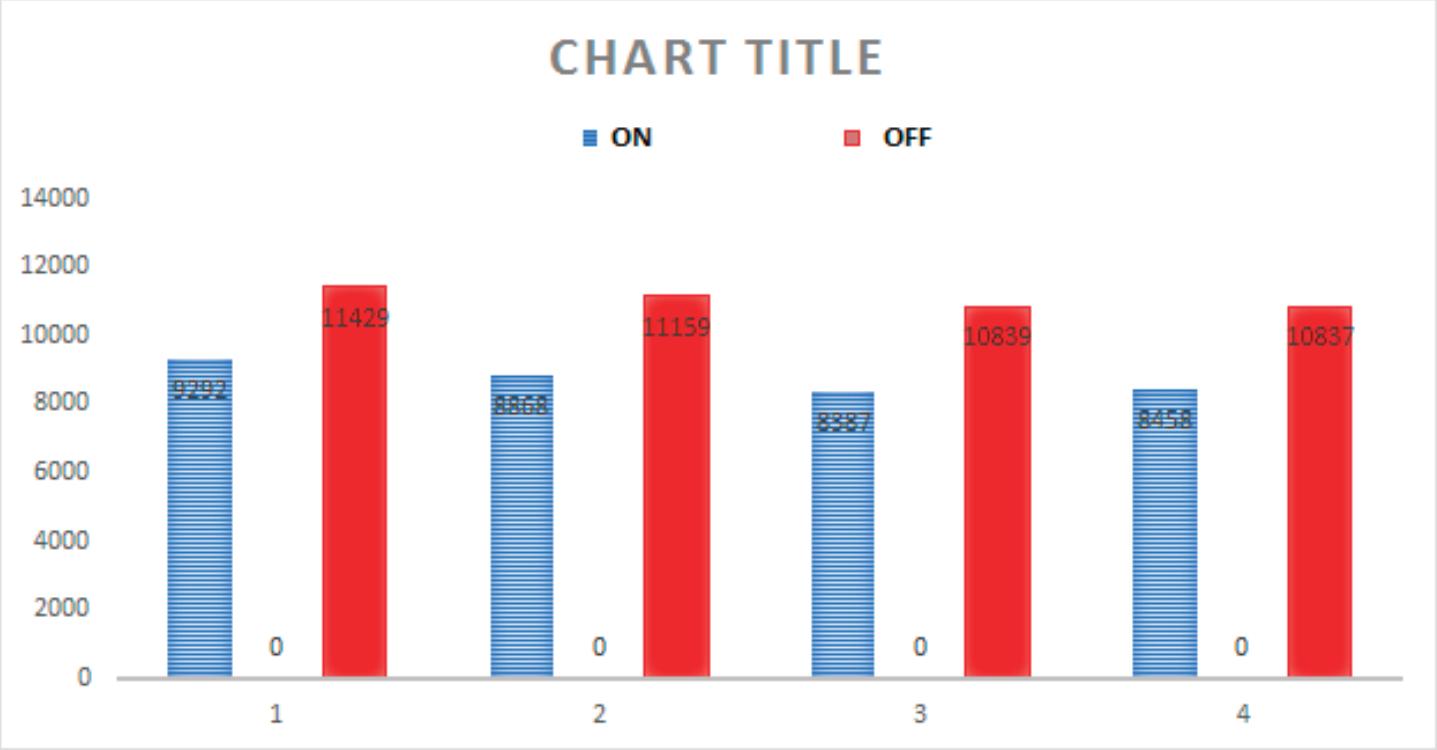
Comparison of total KWh consumed by rack «B» chiller system for 4 consecutive days with adiabatic pre-cooling system OFF – to 4 consecutive days with adiabatic system ON. (with comparative temp. & RH data).
Equipment tested: Air cooled water chillers Petra APSa 325-2.

Date	System	Time	Average Temp C	Average Humidity HR%	Saving KWh	Saving %	Hrs used per test	KWh used per test	Rain	m3 Water consumption
08.09.2017	OFF	15:01	36.20	41.55	0	0	22:15:00	11429	No	0
09.09.2017	OFF	15:00	36.01	39.47	0	0	45:15:00	11159	No	0
10.09.2017	OFF	15:04	36.60	38.52	0	0	72:00:00	10839	No	0
11.09.2017	OFF	15:00	37.42	40.40	0	0	96:00:00	10837	No	0
Total					**0**			**44264**		**0**

Date	System	Time	Average Temp C	Average Humidity HR%	Saving KWh	Saving %	Hrs used per test	KWh used per test	Rain	m3 Water consumption
15.09.2017	ON	14:00	36.09	42.58	2137	19%	96:00:00	9292	No	17.42
16.09.2017	ON	14:03	36.69	45.40	2209	21%	120:00:00	8868	No	15.80
17.09.2017	ON	14:05	35.25	39.57	2501	23%	144:00:00	8387	No	18.34
18.09.2017	ON	14:00	36.49	43.04	2379	22%	167:00:00	8458	No	17.99
Total					**9226**	**21.25%**		**35005**		**69.55**

Test description:

Comparison of total KWh consumed by rack «B» chiller system for 4 consecutive days with adiabatic pre- cooling system OFF – to 4 consecutive days with adiabatic system ON. (with comparative Temp. & RH data).



Chillers energy consumption date 16.09.2017 “Smart Cooling™” system ON vs 09.09.2017 “Smart Cooling™” system OFF.

			Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %
36	date	timestamp	Chiller 6 - E	chiller 6 09/09/2017		chiller 2 - E	chiller 2 09/09/2017		chiller 3 - E	chiller 3 09/09/2017	
37	16.09.2017 00:00	1505505600	150544	226339	33%	113379	151486	25%	107621	50565	
38	16.09.2017 01:00	1505509200	146880	222988	34%	95372	150125	36%	105527	50356	
39	16.09.2017 02:00	1505512800	147089	223513	34%	92127	149811	39%	93383	28476	
40	16.09.2017 03:00	1505516400	145309	221838	34%	91080	150335	39%	67734	47320	
41	16.09.2017 04:00	1505520000	146356	219116	33%	90557	150230	40%	68362	38316	
42	16.09.2017 05:00	1505523600	160804	219535	27%	89824	150544	40%	74120	51089	
43	16.09.2017 06:00	1505527200	183312	221000	17%	92546	150649	39%	80088	51747	
44	16.09.2017 07:00	1505530800	179124	226863	21%	93279	153580	39%	80925	52345	
45	16.09.2017 08:00	1505534400	177554	278580	36%	115473	177554	35%	84380	61558	
46	16.09.2017 09:00	1505538000	184045	283186	35%	120289	184778	35%	110238	62186	
47	16.09.2017 10:00	1505541600	185929	279941	34%	119451	185824	36%	110238	61244	
48	16.09.2017 11:00	1505545200	188651	284338	34%	120289	184045	35%	111390	61662	
49	16.09.2017 12:00	1505548800	191582	279312	31%	122173	184359	34%	113274	62081	
50	16.09.2017 13:00	1505552400	188232	282244	33%	121231	183207	34%	113170	62605	
51	16.09.2017 14:00	1505556000	187290	278788	33%	121126	182370	34%	113379	62081	
52	16.09.2017 15:00	1505559600	197340	278580	29%	120603	173262	30%	113274	61558	
53	16.09.2017 16:00	1505563200	231469	282138	18%	118300	163526	28%	110762	60929	
54	16.09.2017 17:00	1505566800	224978	279105	19%	117881	161013	27%	110343	60615	
55	16.09.2017 18:00	1505570400	220896	275125	20%	115682	160804	28%	108354	59778	
56	16.09.2017 19:00	1505574000	217650	277951	22%	113379	158919	29%	74749	61767	
57	16.09.2017 20:00	1505577600	217231	269158	19%	112646	158814	29%	65117	62395	
58	16.09.2017 21:00	1505581200	215242	271879	21%	111599	155778	28%	64489	52136	
59	16.09.2017 22:00	1505584800	216917	268948	19%	112123	155150	28%	64908	26068	
60	16.09.2017 23:00	1505588400	152638	249581	39%	104271	154103	32%	64489	49937	
61	TOTAL IN KW/H		4457	6200	28%	2625	3930	33%	2210	1299	
62	Difference in KW/H		1743			1306			-912		
63	Total consumtion OFF 24H		1 14 29								
64	Total consumtion ON 24H		92 92								19%
65	Difference Kw/h total 3 units in 24h		21 37								

Chillers energy consumption date 17.09.2017 “Smart Cooling™” system ON vs 10.09.2017 ‘Smart Cooling™’ system OFF

			Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %
69	date	timestamp	Chiller 6 - E	Chiller 6 10/09/ - 13/09		chiller 2 - E	Chiller 6 10/09/ - 13/09		chiller 3 - E	Chiller 6 10/09/ - 13/09	
70	17.09.2017 00:00	1505592000	114217	233354	51%	92022	153057	40%	63756	32768	
71	17.09.2017 01:00	1505595600	127931	233144	45%	90661	154103	41%	63861	40620	
72	17.09.2017 02:00	1505599200	174099	235447	26%	92650	154103	40%	65012	25858	
73	17.09.2017 03:00	1505602800	185301	231469	20%	91604	152114	40%	65536	28476	
74	17.09.2017 04:00	1505606400	182160	229689	21%	91708	152638	40%	64698	21252	
75	17.09.2017 05:00	1505610000	182893	229375	20%	96733	151591	36%	61558	27952	
76	17.09.2017 06:00	1505613600	182998	228957	20%	112542	151905	26%	67734	47948	
77	17.09.2017 07:00	1505617200	188546	233458	19%	114321	153685	26%	76005	52868	
78	17.09.2017 08:00	1505620800	222780	240787	7%	115473	175251	34%	109087	55381	
79	17.09.2017 09:00	1505624400	226653	255338	11%	117567	191687	39%	112646	63023	
80	17.09.2017 10:00	1505628000	233563	262667	11%	120603	183626	34%	114217	63337	
81	17.09.2017 11:00	1505631600	234505	262248	11%	121440	185720	35%	112227	64908	
82	17.09.2017 12:00	1505635200	233668	262143	11%	122173	169388	28%	113274	63023	
83	17.09.2017 13:00	1505638800	232621	265912	13%	122068	161432	24%	114635	63547	
84	17.09.2017 14:00	1505642400	181113	271984	33%	120184	164468	27%	115892	63547	
85	17.09.2017 15:00	1505646000	151277	272298	44%	117462	183521	36%	115578	62081	
86	17.09.2017 16:00	1505649600	153475	272194	44%	121440	177135	31%	96001	61034	
87	17.09.2017 17:00	1505653200	150649	278161	46%	119870	170854	30%	68572	59883	
88	17.09.2017 18:00	1505656800	145205	267587	46%	118195	156721	25%	67211	42190	
89	17.09.2017 19:00	1505660400	146880	264028	44%	116310	157139	26%	66792	52240	
90	17.09.2017 20:00	1505664000	140389	263818	47%	109610	156825	30%	67106	51717	
91	17.09.2017 21:00	1505667600	143844	262353	45%	109401	155883	30%	79460	51507	
92	17.09.2017 22:00	1505671200	143949	261934	45%	102491	155360	34%	78622	37898	
93	17.09.2017 23:00	1505674800	141331	250313	44%	74539	154941	52%	77575	33710	
100		TOTAL IN KW/H	4220	6069	30%	2611	3923	33%	2037	1167	
101		Difference in KW/H	1849			1312			-870		
102		Total consumtion OFF 24H	1 11 59								
103		Total consumtion ON 24H	88 68								21%
104		Difference Kw/h total 3 units in 24h	22 90								

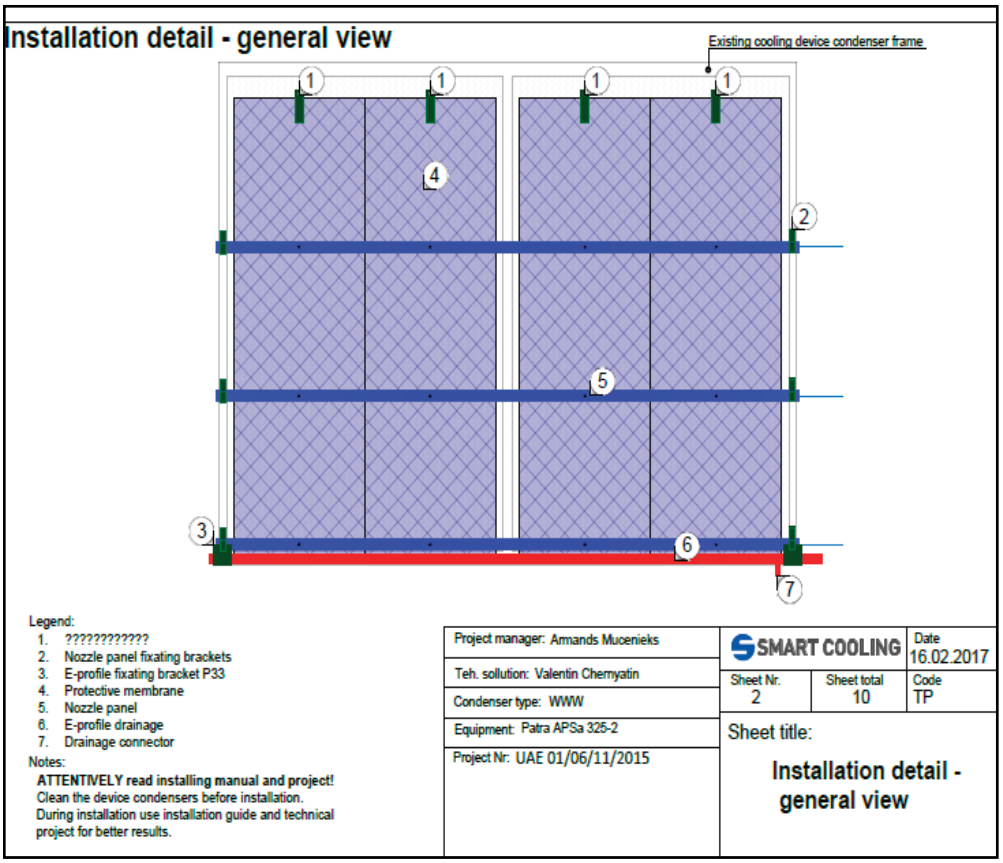
Chillers energy consumption date 18.09.2017 “Smart Cooling™” system ON vs 11.09.2017 “Smart Cooling™” system OFF

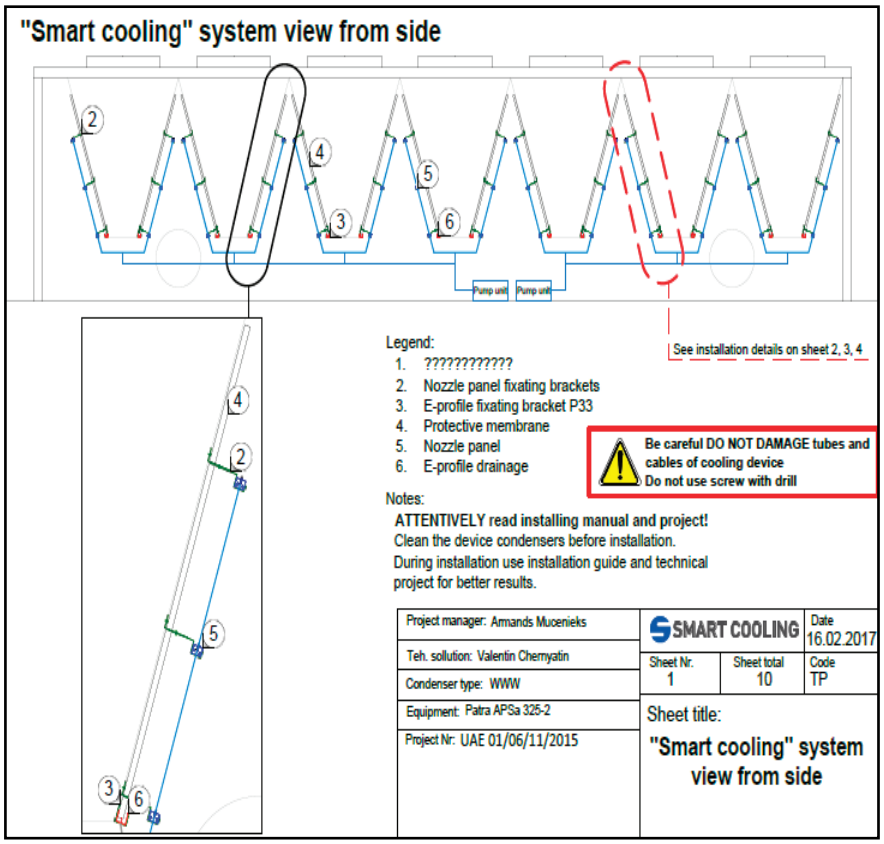
			Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %
109	date	timestamp	Chiller 6 - E	Chiller 6 11/09/2017		chiller 2 - E	chiller 2 08/09/2017		chiller 3 - E	chiller 3 08/09/2017	
110	18.09.2017 01:00	1505682000	137353	235343	42%	72445	153999	53%	79355	29837	
111	18.09.2017 02:00	1505685600	141750	230527	39%	71713	155360	54%	78622	41981	
112	18.09.2017 03:00	1505689200	135573	232830	42%	71294	154627	54%	78413	33710	
113	18.09.2017 04:00	1505692800	141017	228538	38%	71922	152324	53%	78517	19891	
114	18.09.2017 05:00	1505696400	142064	228224	38%	72027	151905	53%	78622	24288	
115	18.09.2017 06:00	1505700000	135992	226653	40%	72341	152324	53%	78831	37793	
116	18.09.2017 07:00	1505703600	164572	230632	29%	81972	153999	47%	79250	50670	
117	18.09.2017 08:00	1505707200	182474	240577	24%	113274	187709	40%	80716	58522	
118	18.09.2017 09:00	1505710800	210741	272508	23%	114112	176507	35%	94326	66478	
119	18.09.2017 10:00	1505714400	228957	276800	17%	116520	143425	19%	110867	66897	
120	18.09.2017 11:00	1505718000	221524	277742	20%	114112	164258	31%	109191	67734	
121	18.09.2017 12:00	1505721600	144577	278894	48%	114112	182684	38%	109191	67734	
122	18.09.2017 13:00	1505725200	133480	279312	52%	113065	182056	38%	90033	67630	
123	18.09.2017 14:00	1505728800	156616	279208	44%	112960	179543	37%	76528	67630	
124	18.09.2017 15:00	1505732400	187709	277533	32%	112856	179962	37%	101340	67630	
125	18.09.2017 16:00	1505736000	217964	280359	22%	110971	179857	38%	115264	67001	
126	18.09.2017 17:00	1505739600	212520	283500	25%	110029	178601	38%	109401	65641	
127	18.09.2017 18:00	1505743200	207914	271147	23%	108563	174099	38%	75795	61976	
128	18.09.2017 19:00	1505746800	206658	265598	22%	108877	154941	30%	78099	55067	
129	18.09.2017 20:00	1505750400	207391	251465	18%	109401	155674	30%	110134	39468	
130	18.09.2017 21:00	1505754000	204983	236076	13%	108354	157454	31%	98304	52031	
131	18.09.2017 22:00	1505757600	162897	233040	30%	96838	155569	38%	67211	51193	
132	18.09.2017 23:00	1505761200	138714	232411	40%	89510	153475	42%	68572	48681	
133		TOTAL IN KW/H	4023	5849	31%	2267	3780	40%	2047	1209	
134		Difference in KW/H	1825			1513			-837		
135		Total consumtion OFF 24H	1 08 39								
136		Total consumtion ON 24H	83 37								23%
137		Difference Kw/h total 3 units in 24h	25 01								

Chillers energy consumption date 19.09.2017 “Smart Cooling™” system ON vs 12.09.2017 “Smart Cooling™” system OFF

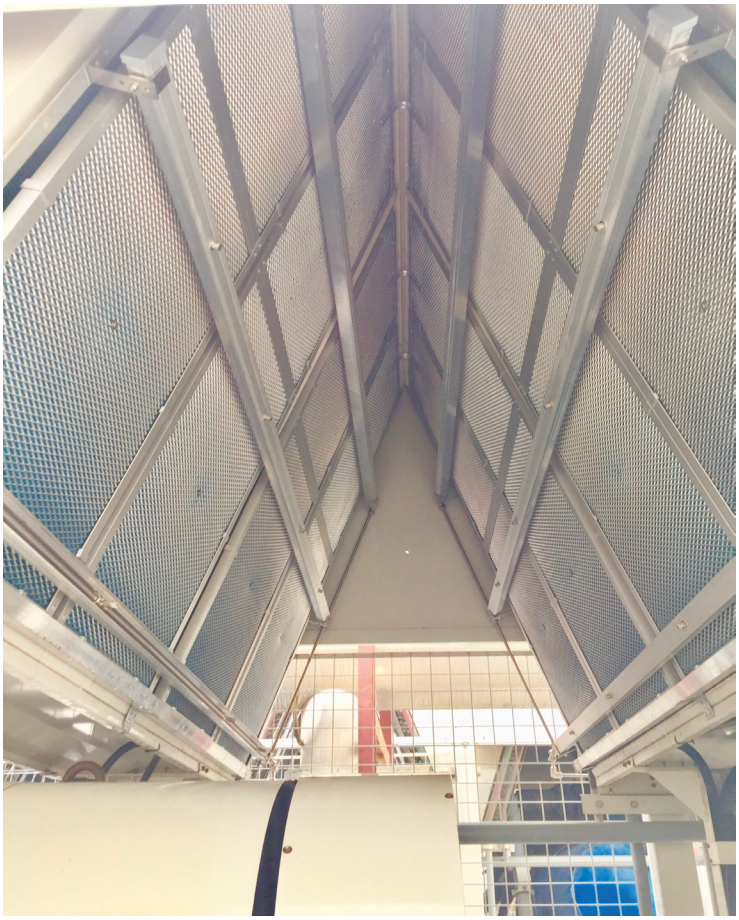
			Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %	Adiabatic on	Adiabatic OFF	Differnece in %
	date	timestamp	Chiller 6 - E	Chiller 6 12/09/2017		chiller 2 - E	chiller 2 08/09/2017		chiller 3 - E	chiller 3 08/09/2017	
	19.09.2017 00:00	1505764800	140703	230108	39%	89510	143111	37%	66792	40410	
	19.09.2017 01:00	1505768400	142483	216499	34%	89510	141959	37%	67211	37060	
	19.09.2017 02:00	1505772000	146461	212102	31%	88149	143216	38%	66478	43237	
	19.09.2017 03:00	1505775600	141645	211264	33%	89929	143216	37%	69723	28476	
	19.09.2017 04:00	1505779200	137562	210950	35%	90138	142483	37%	68467	18425	
	19.09.2017 05:00	1505782800	141017	209275	33%	90452	141331	36%	68781	22299	
	19.09.2017 06:00	1505786400	164886	208856	21%	103957	142169	27%	80821	27219	
	19.09.2017 07:00	1505790000	170854	211997	19%	109924	143844	24%	80192	51403	
	19.09.2017 08:00	1505793600	173157	235238	26%	112437	147927	24%	81867	53287	
	19.09.2017 09:00	1505797200	177554	276591	36%	114321	164886	31%	83857	60092	
	19.09.2017 10:00	1505800800	213567	282348	24%	116310	171168	32%	86578	61244	
	19.09.2017 11:00	1505804400	232621	283500	18%	120079	172424	30%	88777	61767	
	19.09.2017 12:00	1505808000	238169	282663	16%	123011	173262	29%	91080	61558	
	19.09.2017 13:00	1505811600	237122	282977	16%	124476	170644	27%	92441	61662	
	19.09.2017 14:00	1505815200	235133	283081	17%	122487	170854	28%	91918	61139	
	19.09.2017 15:00	1505818800	154522	284338	46%	120184	172215	30%	90975	60720	
	19.09.2017 16:00	1505822400	133061	288944	54%	120707	168027	28%	90871	60720	
	19.09.2017 17:00	1505826000	137144	275753	50%	118718	166457	29%	88882	59359	
	19.09.2017 18:00	1505829600	134736	272612	51%	117985	163526	28%	87521	56533	
	19.09.2017 19:00	1505833200	136201	240787	43%	103015	162060	36%	86788	39573	
	19.09.2017 20:00	1505836800	135573	235657	42%	97362	161118	40%	87311	50251	
	19.09.2017 21:00	1505840400	134945	232097	42%	96001	158396	39%	87207	49623	
	19.09.2017 22:00	1505844000	137144	225188	39%	95582	151277	37%	86893	49623	
	19.09.2017 23:00	1505847600	136097	216499	37%	93802	147613	36%	85950	48995	
	TOTAL IN KW/H		3932	5909		2548	3763		1977	1165	
	Difference in KW/H		1977			1215			-813		
	Total consumtion OFF 24H		1 08 37								
	Total consumtion ON 24H		84 58								22%
	Difference Kw/h total 3 units in 24H		23 79								

SM installation drawings





System installation on chiller condensers

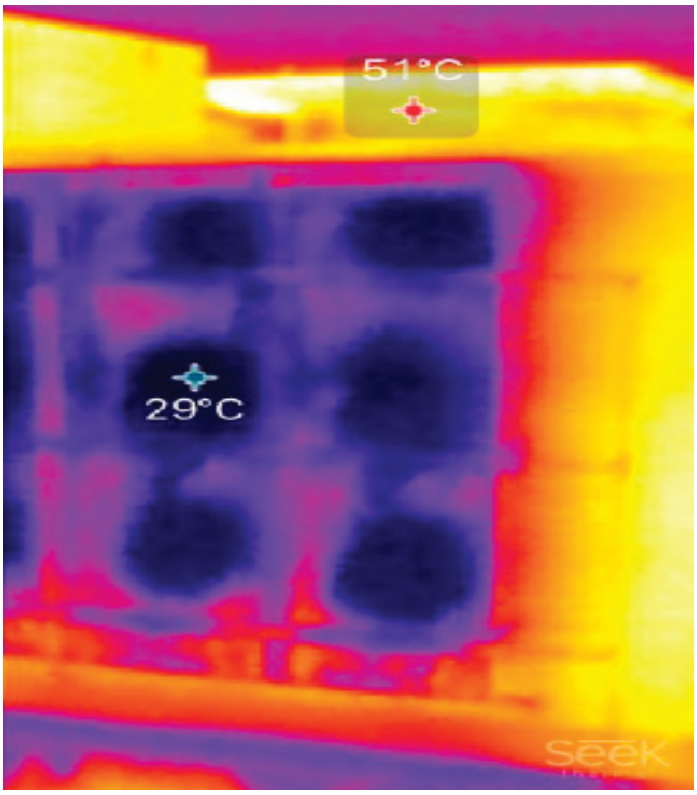


Existing chillers on site

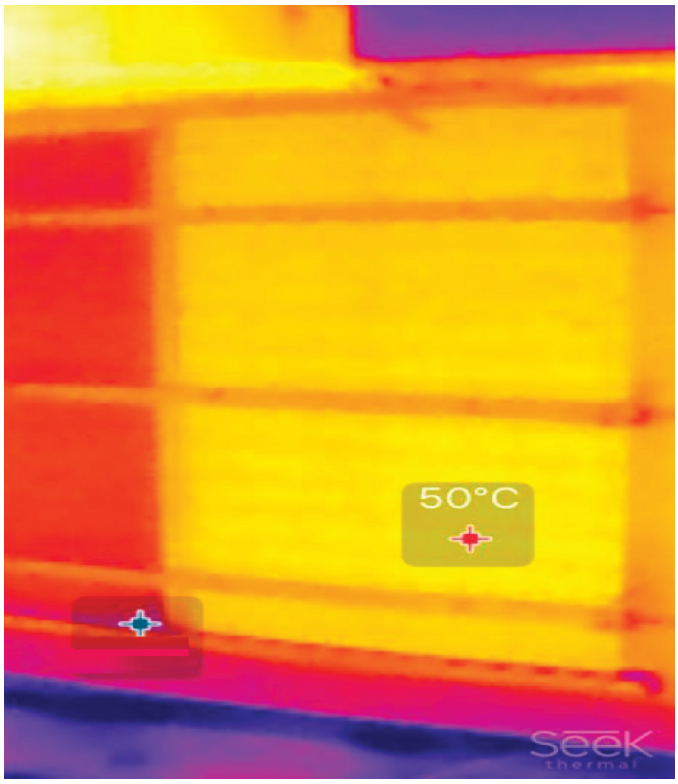
The process

“Smart Cooling™” system reduces incoming air temperature in chiller condensers. Air temperature form 51 C* - until 29 C*. This temperature drop provides higher chiller compressor efficiency.

Temp C* on the condencer Nr. 1 (System ON)



Temp C* on the condencer Nr. 2 (System OFF)



Measurment tools

Enicope analytics, energy measurement system. Cooling power calculator ultrasonic flowmeter RIF 600, thermal camera Testo 882.

Conclusion:

Test results showed that per 4 days “Smart Cooling™” provide energy saving 9226 KWh even at $ 0,11 / KWh, the savings for the test period (4 days) was **$ 1014,86.**
Extrapolated out that would be a savings of **69195 KWh. / USD 7611,45** per month.
The KWh savings incurred during this test equated to a reduction of over 13,000 pounds of CO2 emissions per month.
Taking into account the data obtained, ROI (return of investments) using adiabatic pre-cooling system “Smart Cooling™” in this project is 12 months.

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