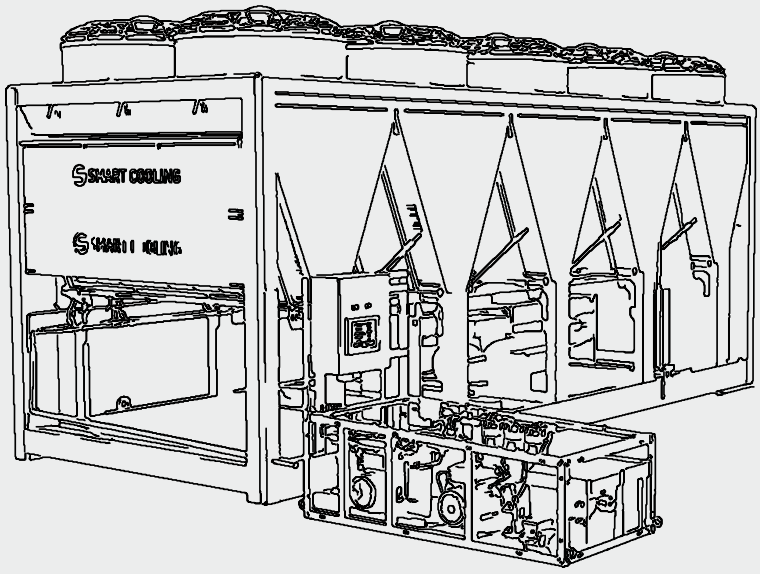
16 June 2019

TEST REPORT

050



SMART COOLING™ PRO10 SYSTEM

Toyota Showroom

Test Participants:
Project name: **TOYOTA SHOWROOM** Location: **Abu dhabi, UAE**
Customer: **AL FUTTAIM MOTORS**
Installer: **Gerab Energy Systems**
Swiss Integrated Energy Technologies: **Ali Soufan**

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Introduction:

Type of structure: Toyota showroom, UAE.
Cooling units: Air cooled water chiller **Carrier 30XA852**, 3 nos of **Carrier 30XA852** chillers upgraded with *Smart Cooling*™ out of 3 chillers totally.
Cooling capacity (manufacturer's data): 838 Kw.
Energy consumption (manufacturer's data): 234 Kw.
Chiller booster: *Smart Cooling*™ *PRO 10*, adiabatic technology with condenser protection.

3-unit chiller retrofits were made to reduce the energy consumption of chillers and to increase chiller COP efficiency. Chillers were equipped with intelligent adiabatic pre-cooling system *Smart Cooling*™ *PRO 10*.

The intelligent adiabatic *Smart Cooling*™ system combines an **adiabatic evaporative pre-cooling process** and **condenser protection with mechanical air filtration**. The intelligent adiabatic *Smart Cooling*™ system is mounted externally in front of the **condensers** of the cooling equipment. *Smart Cooling*™ initiates the **adiabatic process** even before the **mechanical cooling** kicks in and the equipment receives a **temperature-reducing fine mist of processed water** that within the cooling circuit.

Smart Cooling™ ensures 100% condenser protection from direct contact with water.

Main components:

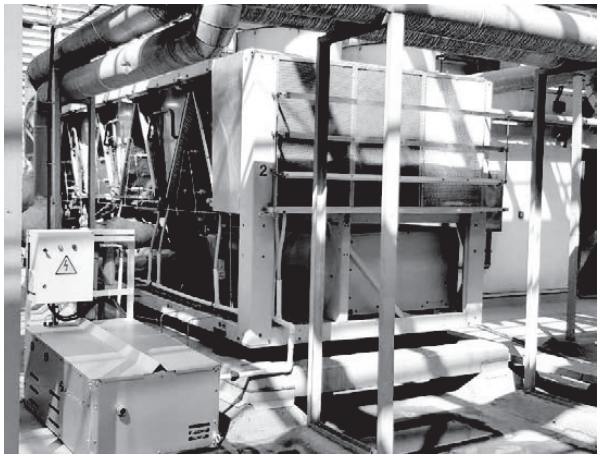
Smart Cooling™ comprises the following key components: protective membranes, water treatment and recirculation systems, high-pressure water pump, control unit, high-pressure nozzle panels, fasteners, and fixings.

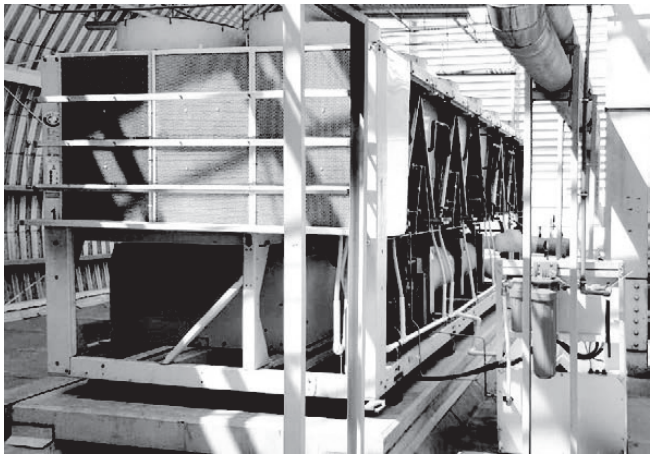
- **Protective membranes** cover the condenser surface, preventing direct water contact.
- **Water system** purifies and sterilizes water to prevent mineral buildup and bacteria.
- **Pump** provides 70 bar pressure.
- **Control unit** regulates operation via real-time data (temperature, humidity, chiller parameters).
- **Nozzles** spray 5–40 μm droplets.
- A set of **fasteners and fixings** ensure the compatibility of the equipment with the chiller.

Measuring instruments:

Measurements used a **RIELS RIF 600 W** ultrasonic flow meter.
It measures flow based on **ultrasound time difference** across the pipe.
Connected to chiller pipes to verify efficiency with *Smart Cooling*™ ON and OFF
Energy data was taken from the **electrical substation**.

- **Formula:**
  COP = Cooling (kW) ÷ Electrical (kW)





- **Test time:** *12 October 2019 – 27 October 2019*

- **Chiller model:** Carrier 30XA602 – 3 Nos equipped with intelligent adiabatic pre-cooling *Smart Cooling*™ device

Ambient temperature (in Celsius) and air relative humidity:

- comparison between air temperature and relative humidity before and past *Smart Cooling*™ condenser coil protective membrane;

- before air inflow into condenser coil.

Ambient air temperature
44°C

Relative air humidity
RH 28

Air temperature behind
Smart Cooling™ condenser
coil protective membrane
29 °C

Relative air humidity behind
Smart Cooling™ condenser
coil protective membrane
RH 75

Testing summary:

The **temperature drop** achieved and measured was of **15°C.** The **average temperature drop** in 14 hours was of 10 to **14 °C**. We see in the data sheet issued by chiller manufacturer "Carrier" the chiller performance in different ambient conditions and with 100% chiller load. As proven by the measurement, the *Smart Cooling*™ system boosts chiller cooling capacity by **10%** and reduces electricity consumption by **24%**.

Cooling capacity Data Sheet

Unit with option 119 (high energy efficiency)

Unit with option 119, LWT = 7°C

	Air temperature, °C																									
	25					30					35					40					46				
30XA	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa
252	295	65	75	14	16	285	72	81	14	15	274	78	88	13	14	263	86	95	13	13	246	96	105	12	11
302	325	72	82	15	16	313	79	89	15	15	300	87	96	14	14	286	95	104	14	13	269	107	116	13	12
352	354	79	89	17	19	341	87	96	16	18	326	96	105	16	16	310	105	114	15	15	291	118	126	14	13
402	420	91	103	20	37	407	99	112	19	35	393	109	121	19	33	378	119	131	18	31	359	133	145	17	28
452	483	107	119	23	40	468	117	129	22	38	451	129	141	22	35	433	141	153	21	33	411	157	169	20	30
502	545	117	131	26	39	527	128	142	25	37	508	140	154	24	35	488	154	168	23	32	462	172	186	22	29
602	660	146	163	31	49	638	159	177	30	46	616	174	191	29	43	593	191	208	28	40	562	213	229	27	37
702	726	154	173	35	40	702	168	188	33	37	677	184	203	32	35	651	201	221	31	33	617	225	244	29	30
752	778	180	199	37	41	753	196	215	36	38	726	215	233	35	36	696	235	254	33	33	663	262	281	32	30
802	849	192	212	40	38	821	209	230	39	36	792	229	249	38	34	762	251	271	36	31	723	280	300	34	28
852	899	196	219	43	43	869	214	237	41	40	838	234	257	40	37	805	256	279	38	35	764	286	308	36	32
902	965	221	244	46	40	933	241	264	44	38	899	263	286	43	35	864	288	311	41	33	820	321	344	39	30
1002	1073	236	265	51	40	1037	258	286	49	37	1000	282	310	48	35	961	309	337	46	33	911	345	373	43	30
1102	1229	266	297	59	46	1189	291	322	57	43	1147	318	348	55	40	1103	348	378	53	37	1046	388	418	50	34
1202	1336	298	331	64	47	1292	325	358	62	45	1247	355	388	59	42	1199	389	421	57	39	1138	434	466	54	35
1302	1452	328	362	69	52	1404	359	392	67	49	1354	393	425	65	46	1301	430	463	62	42	1233	481	513	59	38
1352	1550	362	393	74	48	1497	395	426	71	45	1442	433	463	69	42	1385	474	504	66	39	1311	530	560	62	35
1402	1575	345	386	75	50	1523	376	417	73	47	1468	411	451	70	44	1411	450	490	67	41	1339	503	542	64	37
1502	1636	360	401	78	52	1581	393	434	75	48	1523	430	470	73	45	1463	471	511	70	42	1387	526	565	66	38
1702	1795	391	438	86	63	1736	427	474	83	59	1675	467	513	80	55	1610	512	557	77	51	1527	572	616	73	46

Unit with option 119, LWT = 10°C

	Air temperature, °C																									
	25					30					35					40					46				
30XA	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa	CAP kW	COMP kW	UNIT kW	COOL l/s	COOL kPa
252	323	68	78	15	18	312	75	84	15	17	300	82	91	14	16	287	90	99	14	15	271	100	109	13	13
302	355	76	85	17	19	342	83	93	16	18	328	91	100	16	16	313	100	109	15	15	294	112	121	14	13
352	387	84	93	19	22	372	92	101	18	21	356	101	110	17	19	339	110	119	16	17	318	124	133	15	15
402	460	95	107	22	43	446	104	116	21	41	430	113	126	21	38	414	124	136	20	35	393	138	150	19	32
452	527	113	125	25	46	510	124	136	24	44	492	135	147	23	41	472	148	160	23	38	448	165	177	21	34
502	595	123	138	28	46	575	135	149	27	43	554	147	162	26	40	532	162	176	25	37	504	181	194	24	34
602	722	154	171	34	57	699	168	185	33	54	674	183	200	32	50	648	200	217	31	47	614	223	240	29	42
702	793	162	182	38	46	767	177	197	37	43	740	193	213	35	41	711	211	231	34	38	673	236	255	32	34
752	851	190	209	41	47	823	207	226	39	44	793	226	245	38	41	762	247	266	36	39	723	275	293	35	35
802	929	202	223	44	44	898	220	241	43	42	865	241	261	41	39	832	263	283	40	36	789	293	313	38	33
852	981	207	230	47	49	948	225	249	45	46	914	246	269	44	43	878	269	292	42	40	832	300	323	40	36
902	1055	233	257	50	46	1019	254	277	49	43	981	277	300	47	41	942	303	326	45	38	893	337	360	43	34
1002	1173	250	279	56	46	1133	272	301	54	43	1091	297	326	52	40	1048	325	353	50	38	993	363	390	47	34
1102	1341	281	312	64	53	1297	307	337	62	50	1251	335	365	60	46	1202	365	396	57	43	1140	407	437	54	39
1202	1458	315	348	70	55	1410	343	376	67	52	1359	374	407	65	48	1306	409	441	62	45	1239	456	487	59	41
1302	1586	347	381	76	60	1532	379	412	73	56	1476	414	447	70	53	1418	453	486	68	49	1322	494	525	63	43
1352	1691	384	415	81	56	1632	419	450	78	52	1571	458	489	75	49	1506	501	531	72	45	1351	517	547	65	37
1402	1721	365	405	82	58	1663	397	438	79	55	1602	434	474	76	51	1538	474	513	73	47	1458	528	567	70	43
1502	1786	381	422	85	60	1724	415	456	82	56	1660	453	494	79	52	1594	496	536	76	48	1509	553	592	72	44
1702	1959	413	460	94	73	1894	450	497	90	69	1826	492	538	87	64	1754	538	584	84	59	1663	600	645	79	54

Legend

LWT	Leaving water temperature
CAP kW	Cooling capacity
COMP kW	Compressor power input
UNIT kW	Unit power input (compressors, fans and control circuit)
COOL l/s	Evaporator water flow rate
COOL kPa	Evaporator pressure drop

Application data:

Standard units, refrigerant: R134a
Evaporator temperature rise: 5 K
Evaporator fluid: chilled water
Fouling factor: 0.18 x 10^{-4} (m² K)/W

Performances in accordance with EN 14511.

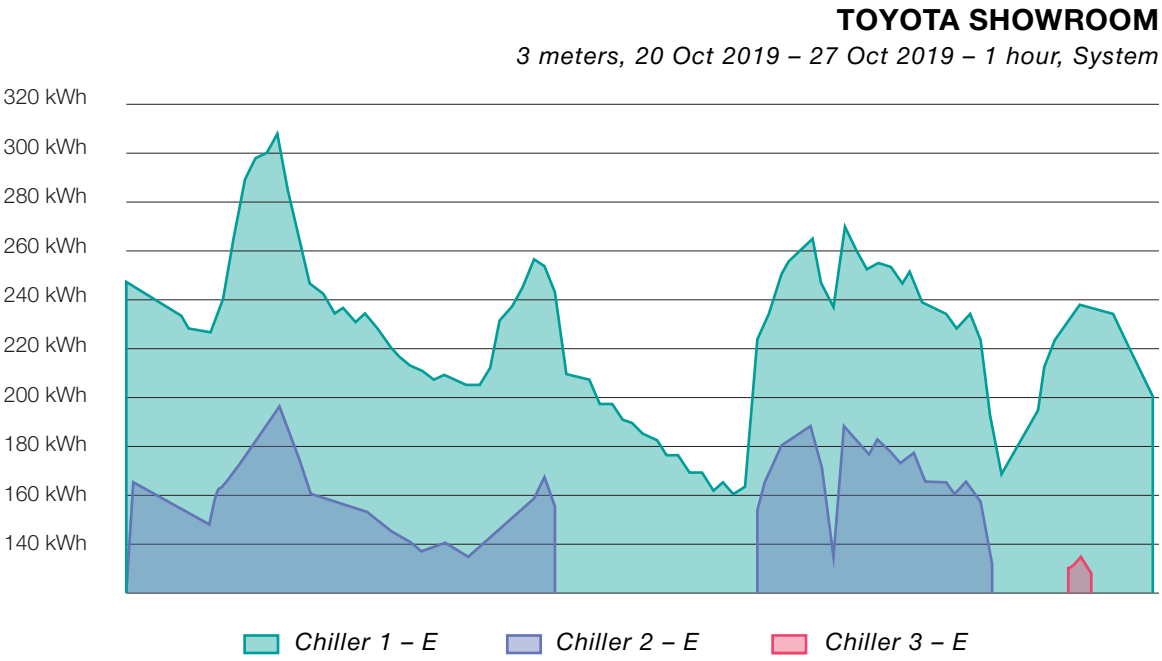
Smart Cooling™ ON

Smart Cooling™ OFF

Summary of 14-day comparison between *Smart Cooling*™ switched **OFF** for 7 days and *Smart Cooling*™ switched **ON** for 7 days

- Average ambient temperature during the period between 12 October 2019 and 19 October 2019 with *Smart Cooling*™ switched **OFF** was **33.9 °C**

- Average ambient temperature during the period between 20 October 2019 and 27 October 2019 with *Smart Cooling*™ switched **ON** was **31.60 °C**

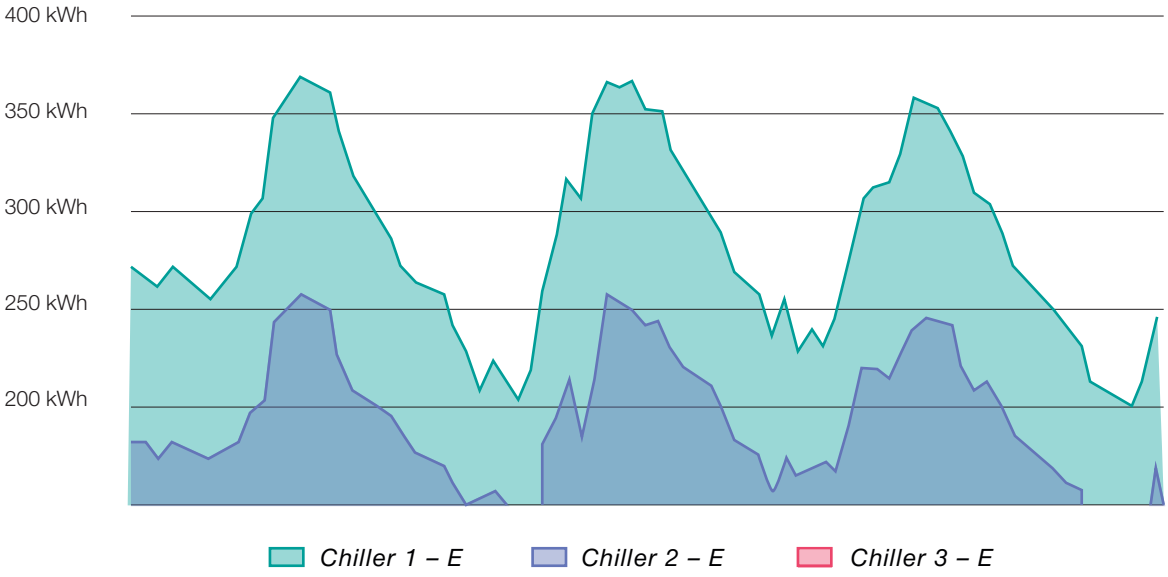


Eniscope Analytics

Meter	Total	Average	Max	Min
Chiller 1 – E	17.66 MWh	91.97 kWh	133.70 kWh	46.97 kWh
Chiller 2 – E	8.32 MWh	43.32 kWh	112.78 kWh	141.33 kWh
Chiller 3 – E	15.78 MWh	15.78 kWh	112.54 kWh	41.50 kWh

TOYOTA SHOWROOM

3 meters, 12 Oct 2019 – 18 Oct 2019 – 1 hour, System



Eniscope Analytics

Meter	Total	Average	Max	Min
Chiller 1 – E	16.71 MWh	99.47 kWh	134.47 kWh	71.14 kWh
Chiller 2 – E	15.09 MWh	89.81 kWh	157.24 kWh	65.43 kWh
Chiller 3 – E	15.07 MWh	89.73 kWh	130.55 kWh	52.97 kWh

Testing Data:

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-20 electricity consumption in W Smart cooling on	Chiller 1 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-20 electricity consumption in W Smart cooling on	Chiller 2 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-20 electricity consumption in	Chiller 3 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off
12.10.2019 00:00	1570924000	93331	32	93593	31	0%	84061	32	69569	31	-26%	85950	32	82705	31	-4%
12.10.2019 01:00	1570927600	91332	32	91290	30	-2%	86210	32	66834	30	-29%	82548	32	82192	30	0%
12.10.2019 02:00	1570931200	89614	32	87730	30	-2%	84221	32	66362	30	-27%	82524	32	81448	30	-1%
12.10.2019 03:00	1570934800	90071	32	87207	29	-4%	86870	32	67734	29	-31%	85215	32	82500	29	-5%
12.10.2019 04:00	1570938400	91294	32	86945	29	-5%	85634	32	67854	29	-30%	82967	32	78573	29	-5%
12.10.2019 05:00	1570942000	89510	32	85542	28	-7%	82755	32	66883	28	-28%	81167	32	76865	28	-5%
12.10.2019 06:00	1570945600	89636	31	82914	28	-3%	84602	31	66630	28	-30%	80821	31	77062	28	-5%
12.10.2019 07:00	1570949200	87730	32	80825	29	-8%	85174	32	66969	29	-28%	81605	32	77571	29	-5%
12.10.2019 08:00	1570952800	94535	34	93697	29	-1%	97875	34	67767	29	-31%	83124	34	78465	29	-6%
12.10.2019 09:00	1570956400	99717	36	102731	32	3%	106574	36	70247	32	-34%	97670	36	92050	32	-5%
12.10.2019 10:00	1570960000	99605	37	102841	36	6%	111052	37	77325	36	-34%	99251	37	110239	36	12%
12.10.2019 11:00	1570963600	123863	40	112998	37	-8%	125064	40	75743	37	-40%	100136	40	110629	37	10%
12.10.2019 12:00	1570967200	126862	41	113032	39	-9%	132851	41	79834	39	-41%	102701	41	109344	39	6%
12.10.2019 13:00	1570970800	127774	41	116151	40	-9%	137144	41	79831	40	-42%	106155	41	112542	40	6%
12.10.2019 14:00	1570974400	121964	42	115211	39	-6%	140015	42	75634	39	-46%	104271	42	99058	39	-9%
12.10.2019 15:00	1570978000	99248	41	103214	37	4%	157244	41	73420	37	-53%	103248	41	91200	37	-10%
12.10.2019 16:00	1570981600	120446	39	95257	36	-21%	113365	39	69189	36	-41%	111547	39	89553	36	-23%
12.10.2019 17:00	1570985200	114635	37	94739	34	-17%	102848	37	64824	34	-37%	105737	37	82981	34	-22%
12.10.2019 18:00	1570988800	110196	36	90563	33	-18%	100916	36	63803	33	-37%	99304	36	80417	33	-19%
12.10.2019 19:00	1570992400	110621	35	90838	32	-19%	98408	35	63458	32	-36%	92736	35	82679	32	-10%
12.10.2019 20:00	1570996000	105841	35	88520	32	-16%	97257	35	63022	32	-35%	88829	35	78298	32	-12%
12.10.2019 21:00	1570999600	102973	34	89940	32	-11%	92232	34	62751	32	-32%	84799	34	81030	32	-4%
12.10.2019 22:00	1571003200	95008	34	83607	31	-12%	90139	34	61950	31	-31%	84275	34	81678	31	-3%
12.10.2019 23:00	1571006800	96524	34	83096	31	-14%	84748	34	61526	31	-27%	83619	34	76700	31	-8%
Total KW/H consumption		2467		2273			2658		1641			2212		2088		
Total KW/H Savings				194					986					126		
Total savings in %				-8%					-38%					-6%		

Comparison of individual chiller electricity kW/h consumption

October 12 vs October 20

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-21 electricity consumption in W Smart cooling on	Chiller 1 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-21 electricity consumption in W Smart cooling on	Chiller 2 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-21 electricity consumption in	Chiller 3 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off
13.10.2019 00:00	1570910400	95562	33	79664	30	-17%	84380	33	60914	30	-28%	82077	33	75292	30	-8%
13.10.2019 01:00	1570914000	91250	33	79617	29	-13%	79931	33	61000	29	-24%	76267	33	71372	29	-6%
13.10.2019 02:00	1570917600	84014	32	75377	29	-10%	76371	32	60725	29	-20%	73597	32	75000	29	2%
13.10.2019 03:00	1570921200	88882	30	76383	29	-14%	74382	30	60160	29	-19%	62973	30	69818	29	32%
13.10.2019 04:00	1570924800	91865	31	78722	28	-14%	73754	31	60019	28	-19%	64070	31	69502	28	9%
13.10.2019 05:00	1570928400	89876	31	78109	28	-13%	70404	31	59736	28	-15%	57579	31	69111	28	20%
13.10.2019 06:00	1570932000	88044	30	74858	27	-15%	67368	30	59548	27	-12%	54543	30	68451	27	25%
13.10.2019 07:00	1570935600	91708	31	77214	28	-16%	65431	31	59924	28	-8%	60205	31	68451	28	0%
13.10.2019 08:00	1570939200	100607	33	80506	30	-20%	69143	33	60443	30	-32%	75743	33	70053	30	-8%
13.10.2019 09:00	1570942800	106470	36	87861	32	-17%	94535	36	61620	32	-35%	91918	36	81737	32	-11%
13.10.2019 10:00	1570946400	118300	38	88944	34	-25%	103015	38	62616	34	-39%	98199	38	86694	34	-13%
13.10.2019 11:00	1570950000	127879	40	93279	36	-27%	66164	40	63458	36	-4%	115735	40	89096	36	-23%
13.10.2019 12:00	1570953600	134474	40	94456	37	-30%	87154	40	64400	37	-26%	136548	40	97519	37	-25%
13.10.2019 13:00	1570957200	126047	40	101711	37	-19%	137039	40	64871	37	-53%	104376	40	86872	37	-17%
13.10.2019 14:00	1570960800	125542	41	100439	36	-20%	136516	41	54742	36	-60%	103486	41	98379	36	-15%
13.10.2019 15:00	1570964400	118614	42	96812	35	-18%	138714	42	24874	35	-82%	110867	42	87154	35	-21%
13.10.2019 16:00	1570968000	112018	41	105857	33	-6%	136673	41	188	33	-100%	106731	41	102183	33	-4%
13.10.2019 17:00	1570971600	117410	39	106259	32	-9%	133846	39	188	32	-100%	103172	39	97048	32	-5%
13.10.2019 18:00	1570975200	109034	37	99120	31	-9%	129606	37	188	31	-100%	95320	37	97142	31	2%
13.10.2019 19:00	1570978800	103591	36	100628	30	-3%	124476	36	188	30	-100%	95086	36	96576	30	2%
13.10.2019 20:00	1570982400	101759	35	94504	30	-7%	122487	35	141	30	-100%	91918	35	95917	30	4%
13.10.2019 21:00	1570986000	102910	35	99827	29	-3%	116310	35	141	29	-100%	86578	35	89792	29	4%
13.10.2019 22:00	1570989600	93436	34	98791	29	6%	113798	34	188	29	-100%	86840	34	85223	29	-2%
13.10.2019 23:00	1570993200	86898	34	96812	30	13%	106004	34	141	30	-100%	84432	34	84516	30	0%
Total KW/H consumption		2506		2168			2427		940			2110		2003		
Total KW/H Savings				338					1486					10 7		
Total savings in %				-13%					-61%					- 5%		

Comparison of individual chiller electricity kW/h consumption

October 13 vs October 21

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-22 electricity consumption in W Smart cooling on	Chiller 1 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-22 electricity consumption in W Smart cooling on	Chiller 2 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-22 electricity consumption in W	Chiller 3 2019-10-20 Smart cooling on T C°	Difference in % between smart cooling on and off
14.10.2019 00:00	1570996800	80758	33	87884	29		104062	33	141	29		83804	33	87164	29	4%
14.10.2019 01:00	1571000400	86578	32	89039	29		97047	32	141	29		78884	32	82448	29	6%
14.10.2019 02:00	1571004000	78517	31	88096	28		86840	31	141	28		76895	31	83841	28	5%
14.10.2019 03:00	1571007600	86421	31	90311	28		95529	31	188	28		77942	31	77544	28	-1%
14.10.2019 04:00	1571011200	85113	31	85741	27		89510	31	141	27		61139	31	76366	27	25%
14.10.2019 05:00	1571014800	85270	30	86882	27		91080	30	141	27		69043	30	77120	27	12%
14.10.2019 06:00	1571018400	82182	30	84966	27		96472	30	141	27		69936	30	72409	27	21%
14.10.2019 07:00	1571022000	87937	30	78627	27		88306	30	5276	27		75220	30	73722	27	5%
14.10.2019 08:00	1571025600	97100	32	77355	28		102230	32	76696	28		81187	32	67980	28	-16%
14.10.2019 09:00	1571029200	107883	34	76837	30		118038	34	88191	30		84432	34	69158	30	-18%
14.10.2019 10:00	1571032800	106841	36	63433	32		121650	36	96729	32		88463	36	71231	32	-19%
14.10.2019 11:00	1571036400	100816	38	63291	34		122644	38	98838	34		94011	38	73398	34	-22%
14.10.2019 12:00	1571040000	107058	39	64752	36		128068	39	101005	36		95320	39	75659	36	-21%
14.10.2019 13:00	1571043600	111599	40	64752	37		134108	40	103596	37		114426	40	76366	37	-33%
14.10.2019 14:00	1571047200	115682	41	66119	36		135626	41	85129	36		106784	41	76413	36	-28%
14.10.2019 15:00	1571050800	114531	40	101900	35		136201	40	92459	35		103852	40	102277	35	-2%
14.10.2019 16:00	1571054400	114217	39	63933	35		134212	39	105366	35		96472	39	81030	35	-16%
14.10.2019 17:00	1571058000	99298	37	61255	34		129187	37	104585	34		102073	37	73369	34	-28%
14.10.2019 18:00	1571061600	93059	35	77591	33		124162	35	101193	33		96524	35	73210	33	-24%
14.10.2019 19:00	1571065200	95111	34	62113	32		124057	34	99544	32		88568	34	72880	32	-18%
14.10.2019 20:00	1571068800	92336	33	61124	32		115159	33	96671	32		85427	33	75942	32	-11%
14.10.2019 21:00	1571072400	86107	33	60417	32		107778	33	93561	32		83809	33	72597	32	-13%
14.10.2019 22:00	1571076000	85375	32	61737	31		102439	32	95163	31		82234	32	74340	31	-10%
14.10.2019 23:00	1571079600	82977	31	77544	31		101611	31	88144	31		80611	31	72456	31	-10%
Total KW/H consumption		2281		2016			2686		1472			2067		1644		
Total KW/H Savings				265					1214					223		
Total savings in %				-12%					-45%					-11%		

Comparison of individual chiller electricity kW/h consumption

October 14 vs October 22

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-23 electricity consumption in W Smart cooling on	Chiller 1 2019-10-20 Smart cooling on T C°	Difference is % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-23 electricity consumption in W Smart cooling on	Chiller 2 2019-10-20 Smart cooling on T C°	Difference is % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-23 electricity consumption in W	Chiller 3 2019-10-20 Smart cooling on T C°	Difference is % between smart cooling on and off
15.10.2019 00:00	1571083200	82443	31	77214	30		94797	31	87201	30		80192	31	70760	30	-12%
15.10.2019 01:00	1571086800	80088	33	77073	29		89510	33	87201	29		75952	30	70147	29	-8%
15.10.2019 02:00	1571090400	78622	29	73822	29		88829	29	85600	29		70195	29	69676	29	-1%
15.10.2019 03:00	1571094000	72288	28	76649	28		81501	28	68544	28		66478	28	69299	28	4%
15.10.2019 04:00	1571097600	71137	28	72362	28		79512	28	85081	28		66687	28	65907	28	-1%
15.10.2019 05:00	1571101200	78360	27	69394	28		78360	27	61291	28		54962	27	61950	28	13%
15.10.2019 06:00	1571104800	77366	27	86165	27		74644	27	188	27		55538	27	81878	27	47%
15.10.2019 07:00	1571108400	74749	28	89039	27		78360	28	188	27		65798	28	83527	27	27%
15.10.2019 08:00	1571112000	82496	30	96435	29		92493	30	188	29		74958	30	89321	29	19%
15.10.2019 09:00	1571115600	92965	31	98367	31		99298	31	188	31		80611	31	99322	31	18%
15.10.2019 10:00	1571119200	79617	35	105245	33		118771	35	188	33		84485	35	106611	33	26%
15.10.2019 11:00	1571122800	99089	37	119343	35		116834	37	188	35		94901	37	103407	35	9%
15.10.2019 12:00	1571126400	109668	38	128559	36		124057	38	188	36		93750	38	102418	36	9%
15.10.2019 13:00	1571130000	105580	40	131862	37		130286	40	188	37		103800	40	105857	37	2%
15.10.2019 14:00	1571133600	113536	40	126192	37		130077	40	188	37		100650	40	110521	37	10%
15.10.2019 15:00	1571137200	108197	40	124607	36		130129	40	236	36		102852	40	112170	36	8%
15.10.2019 16:00	1571140800	114112	38	124419	34		91656	38	188	34		102544	38	110144	34	7%
15.10.2019 17:00	1571144400	113850	37	122440	33		77470	37	188	33		106784	37	100581	33	-6%
15.10.2019 18:00	1571148000	100816	35	116259	32		75377	35	236	32		100345	35	95482	32	-4%
15.10.2019 19:00	1571151600	98304	34	112971	31		74016	34	188	31		98775	34	96058	31	-3%
15.10.2019 20:00	1571155200	100764	33	106375	30		72812	33	188	30		92598	33	92902	30	0%
15.10.2019 21:00	1571158800	98094	33	103313	30		71241	33	236	30		91865	33	100251	30	9%
15.10.2019 22:00	1571162400	94064	32	102554	29		70613	32	188	29		88620	32	92566	29	5%
15.10.2019 23:00	1571166000	92389	31	100523	29		69828	31	188	29		87416	31	90264	29	3%
Total KW/H consumption		2218		2442			2290		499			2042		2178		
Total KW/H Savings				-224					1712					-136		
Total savings in %				10%					-77%					7%		

Comparison of individual chiller electricity kW/h consumption

October 15 vs October 23

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-24 electricity consumption in W Smart cooling on	Chiller 1 2019-10-24 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-24 electricity consumption in W Smart cooling on	Chiller 2 2019-10-24 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-24 electricity consumption in W	Chiller 3 2019-10-24 Smart cooling on T C°	Difference in % between smart cooling on and off
16.10.2019 00:00	1571169600	92022	31	101146	29		69409	31	188	29		84066	31	91300	29	9%
16.10.2019 01:00	1571173200	87730	30	101099	29		68886	30	188	29		83386	30	88238	29	6%
16.10.2019 02:00	1571176800	87154	30	98037	28		68572	30	188	28		81344	30	89368	28	10%
16.10.2019 03:00	1571180400	85689	29	94880	28		67530	29	188	28		78779	29	90640	28	15%
16.10.2019 04:00	1571184000	80192	28	93373	28		67211	28	188	28		77942	28	86118	28	10%
16.10.2019 05:00	1571187600	81553	28	94645	27		66373	28	188	27		77052	28	87154	27	13%
16.10.2019 06:00	1571191200	74068	28	88803	27		66164	28	188	27		76371	28	84281	27	10%
16.10.2019 07:00	1571194800	80402	29	92896	28		66792	29	141	28		76999	29	85647	28	11%
16.10.2019 08:00	1571198400	88358	30	99859	30		68467	30	188	30		79146	30	88992	30	12%
16.10.2019 09:00	1571202000	101340	31	95399	31		70037	31	188	31		86788	31	94604	31	9%
16.10.2019 10:00	1571205600	104796	34	116468	34		72445	34	188	34		86946	34	100676	34	16%
16.10.2019 11:00	1571209200	113903	36	123759	37		74277	36	188	37		104690	36	107062	37	2%
16.10.2019 12:00	1571212800	120603	38	124560	38		77470	38	188	38		108563	38	101146	38	-7%
16.10.2019 13:00	1571216400	126936	40	133464	38		79721	40	236	38		120027	40	101900	38	-15%
16.10.2019 14:00	1571220000	115735	40	131155	39		80140	40	188	39		120655	40	104350	39	-14%
16.10.2019 15:00	1571223600	120603	39	133899	38		79198	39	188	38		115368	39	104161	38	-10%
16.10.2019 16:00	1571227200	122435	37	125220	36		77869	37	236	36		106993	37	101664	36	-5%
16.10.2019 17:00	1571230800	120603	37	120038	34		77362	37	188	34		104699	37	107506	34	2%
16.10.2019 18:00	1571234400	108302	36	113065	32		76167	36	236	32		96042	36	107223	32	9%
16.10.2019 19:00	1571238000	105004	34	108542	31		73859	34	188	31		94326	34	112170	31	19%
16.10.2019 20:00	1571241600	102177	33	110952	30		72184	33	236	30		90975	33	109343	30	20%
16.10.2019 21:00	1571245200	101916	33	105669	30		71241	33	188	30		92860	33	98655	30	6%
16.10.2019 22:00	1571248800	97414	32	99874	30		70613	32	188	30		92336	32	102795	30	11%
16.10.2019 23:00	1571252400	94221	31	107270	29		70352	31	188	29		97205	31	95210	29	-2%
Total KW/H consumption		2413		2611			1731		5			2236		2340		
Total KW/H Savings				-198					1726					-104		
Total savings in %				8%					-100%					5%		

Comparison of individual chiller electricity kW/h consumption

October 16 vs October 24

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-25 electricity consumption in W Smart cooling on	Chiller 1 2019-10-25 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-25 electricity consumption in W Smart cooling on	Chiller 2 2019-10-25 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-25 electricity consumption in W	Chiller 3 2019-10-25 Smart cooling on T C°	Difference in % between smart cooling on and off
17.10.2019 00:00	1571256000	96786	31	100015	28		70142	31	188	28		86631	31	94080	28	9%
17.10.2019 01:00	1571259600	94064	31	99803	28		69862	31	188	28		81396	31	89540	28	10%
17.10.2019 02:00	1571263200	90661	31	102041	28		69305	31	188	28		83122	31	87061	28	4%
17.10.2019 03:00	1571266800	86474	29	98649	28		68205	29	188	28		79983	29	87672	28	10%
17.10.2019 04:00	1571270400	81658	28	96812	26		66944	28	188	26		77156	28	86118	28	12%
17.10.2019 05:00	1571274000	81239	28	89867	27		66583	28	188	27		76738	28	86636	27	13%
17.10.2019 06:00	1571277600	75980	28	89039	27		66583	28	188	27		71398	28	85458	27	20%
17.10.2019 07:00	1571281200	76256	29	92064	28		67316	29	188	28		78151	29	82302	28	5%
17.10.2019 08:00	1571284800	93540	31	91960	30		69619	31	188	30		80873	31	84563	30	5%
17.10.2019 09:00	1571288400	97623	33	103078	31		71660	33	188	31		89875	33	83857	32	-7%
17.10.2019 10:00	1571292000	103381	34	98920	33		73492	34	141	33		86893	34	73681	33	-15%
17.10.2019 11:00	1571295600	105266	37	119613	36		76110	37	188	36		99455	37	97707	36	-2%
17.10.2019 12:00	1571299200	120341	39	120791	38		78088	39	188	38		105684	39	99686	38	-6%
17.10.2019 13:00	1571302800	123534	40	118436	38		81187	40	188	38		115106	40	102936	38	-11%
17.10.2019 14:00	1571306400	131176	41	123900	38		83281	41	236	38		110154	41	99073	38	-10%
17.10.2019 15:00	1571310000	125418	41	122063	38		83071	41	188	38		114583	41	97471	38	-15%
17.10.2019 16:00	1571313600	119096	40	117775	36		81987	40	188	36		111290	40	93561	36	-16%
17.10.2019 17:00	1571317200	85542	38	110757	35		79060	38	188	35		114164	38	90559	35	-21%
17.10.2019 18:00	1571320800	94326	36	104725	32		76842	36	236	32		97047	36	84281	32	-13%
17.10.2019 19:00	1571324400	96053	34	93467	31		74644	34	188	31		92912	34	82268	31	-12%
17.10.2019 20:00	1571328000	100921	34	93137	30		73754	34	188	30		91499	34	84657	30	-7%
17.10.2019 21:00	1571331600	95979	33	90640	29		72759	33	188	29		90133	33	86495	29	-4%
17.10.2019 22:00	1571335200	102701	33	91206	29		72027	33	188	29		89875	33	86227	29	-1%
17.10.2019 23:00	1571338800	95351	32	91771	29		70980	32	188	29		87835	32	83574	29	-5%
Total KW/H consumption		2382		2430			1764		5			2222		2134		
Total KW/H Savings				-49					1759					89		
Total savings in %				2%					-100%					-4%		

Comparison of individual chiller electricity kW/h consumption

October 17 vs October 25

date	timestamp	Chiller 1 electricity consumption in W - E Smart Cooling Off	Chiller 1 T C°	Chiller 1 2019-10-25 electricity consumption in W Smart cooling on	Chiller 1 2019-10-25 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 2 electricity consumption in W E Smart Cooling Off	Chiller 2 - T C°	Chiller 2 2019-10-25 electricity consumption in W Smart cooling on	Chiller 2 2019-10-25 Smart cooling on T C°	Difference in % between smart cooling on and off	Chiller 3 electricity consumption in W Smart Cooling Off	Chiller 3 Smart Cooling Off T C°	Chiller 3 2019-10-25 electricity consumption in W	Chiller 3 2019-10-25 Smart cooling on T C°	Difference in % between smart cooling on and off
17.10.2019 00:00	1571256000	96786	31	100015	28		70142	31	188	28		86631	31	94080	28	9%
17.10.2019 01:00	1571259600	94064	31	99403	28		69862	31	188	28		81396	31	89640	28	10%
17.10.2019 02:00	1571263200	90661	31	102041	28		69305	31	188	28		83122	31	87861	28	-6%
17.10.2019 03:00	1571266800	86474	29	98649	28		68205	29	188	28		79983	29	87672	28	10%
17.10.2019 04:00	1571270400	81658	28	96812	28		66844	28	188	28		77155	28	86118	28	12%
17.10.2019 05:00	1571274000	81239	28	89887	27		66583	28	188	27		76738	28	80636	27	13%
17.10.2019 06:00	1571277600	75980	28	89039	27		66583	28	188	27		71398	28	85458	27	20%
17.10.2019 07:00	1571281200	76256	29	92564	28		67316	29	188	28		78151	29	82362	28	5%
17.10.2019 08:00	1571284800	93540	31	91560	30		69619	31	188	30		80873	31	84563	30	5%
17.10.2019 09:00	1571288400	97623	33	103078	31		71660	33	188	31		89875	33	83857	32	-7%
17.10.2019 10:00	1571292000	103381	34	98823	33		73402	34	141	33		86893	34	73681	33	-15%
17.10.2019 11:00	1571295600	105266	37	119613	36		75110	37	188	36		99455	37	97707	36	-2%
17.10.2019 12:00	1571299200	120341	39	120791	38		78988	39	188	38		105684	39	99686	38	-6%
17.10.2019 13:00	1571302800	123534	40	118436	38		81187	40	188	38		115106	40	102936	38	-11%
17.10.2019 14:00	1571306400	131176	41	123900	38		83261	41	236	38		110104	41	99073	38	-10%
17.10.2019 15:00	1571310000	125418	41	122063	38		83071	41	188	38		114583	41	97471	38	-15%
17.10.2019 16:00	1571313600	119056	40	117776	36		81957	40	188	36		111390	40	93561	36	-16%
17.10.2019 17:00	1571317200	83542	38	110757	35		79000	38	188	35		114164	38	90550	35	-21%
17.10.2019 18:00	1571320800	94326	36	104726	32		76842	36	236	32		97847	36	84281	32	-13%
17.10.2019 19:00	1571324400	96053	34	93467	31		74544	34	188	31		92912	34	82208	31	-12%
17.10.2019 20:00	1571328000	100921	34	93137	30		73754	34	188	30		91499	34	84657	30	-7%
17.10.2019 21:00	1571331600	95579	33	90640	29		72755	33	188	29		90135	33	86495	29	-4%
17.10.2019 22:00	1571335200	102701	33	91206	29		72027	33	188	29		89875	33	86227	29	-1%
17.10.2019 23:00	1571338800	99351	32	91771	29		70980	32	188	29		87835	32	83574	29	-5%
Total KW/H consumption		2382		2430			1764		5			2222		2134		
Total KW/H Savings				-49					1759					89		
Total savings in %				2%					-100%					-4%		

Comparison of individual chiller electricity kW/h consumption

October 18 vs October 26

Total chiller electricity consumption comparison for 7 days – in kw/h

		Smart Cooling™ OFF Chiller 1 electricity consumption	Smart Cooling™ ON Chiller 1 electricity consumption 2019-10-26	Smart Cooling™ OFF Chiller 2 electricity consumption	Smart Cooling™ ON Chiller 2 electricity consumption 2019-10-26	Smart Cooling™ OFF Chiller 3 electricity consumption	Smart Cooling™ ON Chiller 3 electricity consumption 2019-10-26
Total chiller KW/h consumption in 7 days		16 711	15 885	15 088	6 102	15075	14 306
Difference/Kw/h savings in 7 days			825		8 986		769

Conclusion:

- Average ambient temperature during the period between *12/10/2019 - 19/10/2019* with *Smart Cooling*™ switched OFF was 33.9 degrees Celsius
- Average ambient temperature during the period between *20 October 2019 - 27 October 2019* with *Smart Cooling*™ switched ON was 31.60 degrees Celsius

1. Total 7-day consumption of three chillers with *Smart Cooling*™ OFF *(kW/h)*: **46 873 kW/h**
2. Total 7-day consumption of three chillers with *Smart Cooling*™ ON *(kW/h)*: **36 293 KW/h**
3. Total savings in kW/h: **10 580 KW/h**
4. Savings in percentage: **22.57%**
5. 7-day usage of water: **50 m3**

The estimated savings based on a **10°C** temperature decrease and 100% of chiller load was of **543 Kw/h** per chiller within 24 hours with *Smart Cooling*™ operating for 14 hours.
Based on site measurements we can see that without *Smart Cooling*™ all three chillers operate with an average load of **50%**, while with *Smart Cooling*™ in operation the third chiller goes into standby mode due to sufficient cooling capacity. The operating chillers remain at load levels of **50-60%**.
With 50%-60% chiller load, *Smart Cooling*™ was able to deliver an average of **503 Kw/h** savings per chiller within 24 hours, significantly more than expected. Such results are achieved due to *Smart Cooling*™ decrease of, on average, **15°C** and increased operating time.

Ali Soufan _____
30 October 2019

Annex:

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RIF600 | Clamp-on Ultrasonic Meter Calibration Report

Pipe diameter	DN80		Date	15/12/2018
Ambient temperature	29°C			
Standard Device before test	Normal		Model:	RIF600W
Standard Devide After Test	Normal			
Test result	Qualified			
Measured Medium	Water			
Accuracy	1%			
Signal Strength	UP:	90		
	DOWN:	90		
Standard device name	Static volumetric method/standard Meter Method Water Flow/Standard Device			
Standard device accuracy	0,20%			

Test	Standard Meter flow		Temperature	Pressure	Tested Meter Flow		Basic Error		Repeatability	
Point	m3/h		°C	Mpa	m3/h		%		%	
Point 1	101,52	101,47	25,0	0,300	102,27	102,10	0,739		-0,147	
	101,47		25,0	0,300	102,07		0,591			
	101,42		25,0	0,300	101,97		0,542			
Point 2	71,27	71,27	25,0	0,300	71,75	71,75	0,673	0,759	-0,146	0,147
	71,19		25,0	0,300	71,65		0,646			
	71,34		25,0	0,300	71,86		0,729			
Point 3	26,32	26,36	25,0	0,300	26,51	26,55	0,722		-0,132	
	26,36		25,0	0,300	26,56		0,759			
	26,39		25,0	0,300	26,58		0,720			

Verification Based on JJG 1030-2007 < Ultrasonic flowmeter verification procedures >
Scale Factor=1

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RIF600 |Test Report misuratore di portata ad ultrasuoni clamp on

Diametro tubazione	DN80		Date	15/12/2018
Temperatura ambiente	29°C			
Dispositivo standard prima del test	Normale		Model:	RIF600W
Dispositivo standard dop il test	Normale			
Risultato del test	Qualified			
Liquido	Acqua			
Accuratezza	1%			
Potenza dei segnali	UP:	90		
	DOWN:	90		
Tipo di dispositivo standard	Metodo volumetrico statico/Misuratore di portata volumetrico			
Accuratezza del dispositivo standa	0,20%			

Test	Misuratore standard		Temperatura	Pressione	Misuratore testato		errore base		Ripetibilità	
Punti	m3/h		°C	Mpa	m3/h		%		%	
Punto 1	101,52	101,47	25,0	0,300	102,27	102,10	0,739	0,759	-0,147	0,147
	101,47		25,0	0,300	102,07		0,591			
	101,42		25,0	0,300	101,97		0,542			
Punto 2	71,27	71,27	25,0	0,300	71,75	71,75	0,673		-0,146	
	71,19		25,0	0,300	71,65		0,646			
	71,34		25,0	0,300	71,86		0,729			
Punto 3	26,32	26,36	25,0	0,300	26,51	26,55	0,722		-0,132	
	26,36		25,0	0,300	26,56		0,759			
	26,39		25,0	0,300	26,58		0,720			

Verification Based on JJG 1030-2007 < Ultrasonic flowmeter verification procedures >
Scale Factor=1