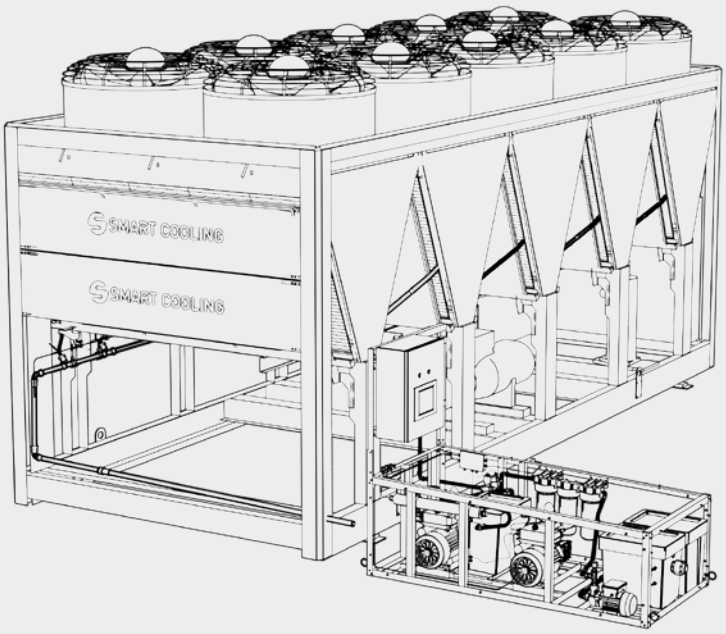
31 July 2019

TEST REPORT 045



SMART COOLING™ PRO10 SYSTEM

Double Tree by Hilton

Test Participants:
Project name: **DUBAI AL BARSHA HOTEL** Location: **Dubai, UAE**
Carrier UTS Engineer: **Iftikhar Amin**
Hilton al Barsha Hotel Engineer: **Jethi Thoma**
Gerab Energy Systems Engineer: **Ali Soufan**
Swiss Integrated Energy Technologies: **Luca Gallarate**

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Introduction:

Type of structure: Multistory hotel building.
Cooling units: Air cooled water chiller **Carrier 30XA 1002** (2 units)**.**
Cooling capacity per manufacturer: 1000 kW
Electricity consumption per manufacturer: 344 kW
Chiller booster: *Smart Cooling™ PRO 10*, adiabatic technology with condenser protection.

Chillers were retrofitted with the intelligent adiabatic *Smart Cooling™* system to reduce electricity consumption and increase COP.

System description (full original text preserved):

- Combines adiabatic evaporative **pre-cooling + condenser protection + mechanical air filtration**
- **Mounted externally** in front of condensers
- **Initiates adiabatic cooling** before mechanical cooling
- Applies fine mist of processed water **to reduce condensation temperature**.

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:

- RIF600 ultrasonic waterflow meter
- Eniscope Analytics energy monitoring
- COP formula: El/kw ÷ cooling/kw = COP

Chiller **with** *Smart Cooling™ system*

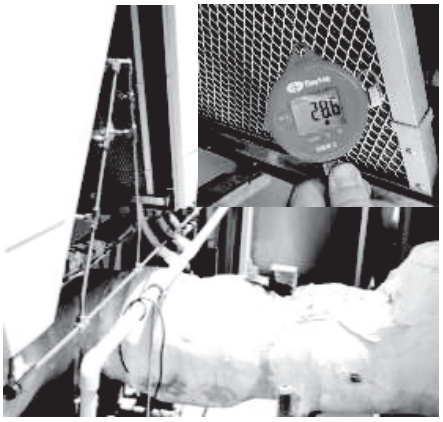
Chiller **without** *Smart Cooling™ system*

- **Equipment tested:** Air-cooled water chillers, **CARRIER 30XA1002**.

Picture No.2
Chiller equipped with chiller equipped with **Smart Cooling™**

Testing procedures

A data logger was installed on the subject HVAC equipment to collect all applicable real-time electricity
consumption and unit performance statistics. Data was collected by the Eniscope Analytics device.



Temperature probe Nr.1
Probe showing inflowing air temperature past the protective membrane: **+28.6º** *Celsius.*

Temperature probe Nr.2
Probe showing inflowing air temperature before reaching the protective membrane: **+43.0º** *Celsius.*

During the first 5 days (120 hours of use) of testing measured electricity consumption by the condenser without *Smart Cooling*™. During this period the chillers consumed **70,112 KW/h**. Water consumption was **0 m³** and the average temperature and relative humidity during the period were **36°C** and **34%** RH.

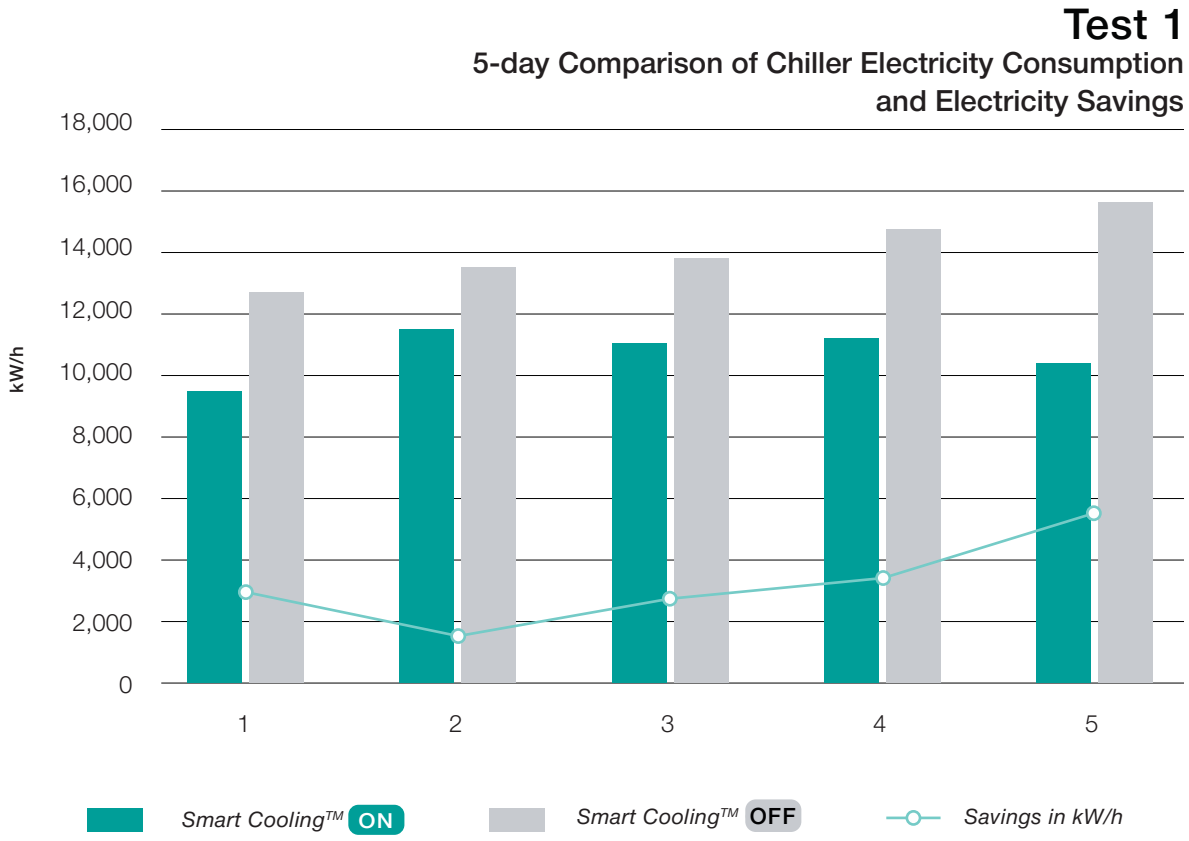
During the following 5 days (120 hours of use), with *Smart Cooling*™ switched on and fully operational, data gathered shows the chiller consumed **53,386 KW/h**. Water consumption was **88 m³** and the average temperature and relative humidity during the period were **36°C** and **45% RH**.

After analyzing the monitoring, results show that energy savings gain delivered by *Smart Cooling*™ during 5 operating days was **16,726 KW/h**.

In the following pages, tables discriminate electricity consumption, air temperature and operating periods, before and after *Smart Cooling*™.

5-day Periods On-Off Testing Measurement Outcomes

With *Smart Cooling*™, in a period of 5 days, the customer economized **16,726 kw/h** of electricity. Electricity supply charges were, at the time, **0.46 Emirati Dirham (AED)** per kw/h. Thus, total savings in electricity charges were of **7,693 AED**.
Water usage during the period was **88 m³** and water supply charges at the time were **10.5 AED** per m³.
In total, water supply expenses were of **924 AED**.



Smart Cooling™ granted total savings post running costs of **6,769 AED** in 5 days or **1,353 AED** per day. On average, *Smart Cooling*™ reduced electricity consumption by **3,345 kw/h** per day.

Smart Cooling™ engineers forecasted **17%** savings for a 14-hour period within a 24-hour operational period – initially evaluated as **755 kw/h** savings based on a **10°C** temperature drop.

However, the results measured during the system's operation show that *Smart Cooling's* ™ performance went well beyond predictions, delivering on average a **14°C** decrease and further boosting chiller efficiency.

Test 1

Five-day electricity consumption comparison – 17 to 21 June with *Smart Cooling*™ OFF and 3 to 7 June with *Smart Cooling*™ ON

Date	Total chiller consumption in KWh with Smart Cooling™ OFF 17 June	Total chiller consumption in kwh with Smart Cooling™ ON 3 June	Savings in kwh	Savings in %	Chiller load with Smart Cooling™ OFF	Chiller load with Smart Cooling™ ON	Temperature with Smart Cooling™ OFF 17 June	Temperature with Smart Cooling™ ON 3 June
17/06/2019 00:00	526	292	236	45%			33.49	31.00
17/06/2019 01:00	504	347	157	31%			33.24	30.44
17/06/2019 02:00	496	302	193	39%			32.79	30.01
17/06/2019 03:00	480	304	176	37%			32.59	29.87
17/06/2019 04:00	480	368	112	23%			32.51	30.02
17/06/2019 05:00	468	302	166	35%			32.26	29.87
17/06/2019 06:00	443	304	139	31%			31.21	29.79
17/06/2019 07:00	412	338	78	18%			32.13	30.99
17/06/2019 08:00	469	365	104	22%			34.63	34.04
17/06/2019 09:00	497	391	105	21%			36.81	34.78
17/06/2019 10:00	499	394	104	21%			38.01	35.96
17/06/2019 11:00	519	397	122	24%			41.79	38.24
17/06/2019 12:00	572	379	193	34%	64%	57%	42.82	38.82
17/06/2019 13:00	581	400	182	31%			39.74	36.75
17/06/2019 14:00	569	427	142	25%			38.05	36.26
15:00	564	506	59	10%			37.39	35.12
16:00	565	470	95	17%			36.11	34.58
17:00	595	493	102	17%			35.42	34.00
18:00	606	483	123	20%			34.10	33.02
19:00	565	454	111	20%			33.54	32.48
20:00	543	440	103	19%			33.17	32.38
21:00	566	413	153	27%			32.79	32.29
22:00	496	451	45	9%			32.25	32.17
23:00	467	391	76	16%			32.05	32.38
Day Total	13483	9408	3075	25%				

Date	Total chiller consumption in KWh with Smart Cooling™ OFF 18 June	Total chiller consumption in kwh with Smart Cooling™ ON 4 June	Savings in kwh	Savings in %	Chiller load with Smart Cooling™ OFF	Chiller load with Smart Cooling™ ON	Temperature with Smart Cooling™ OFF 18 June	Temperature with Smart Cooling™ ON 4 June
18/06/2019 00:00	526	429	97	18%			32.28	32.62
18/06/2019 01:00	512	447	65	13%			32.13	31.53
18/06/2019 02:00	508	394	113	22%			31.88	30.42
18/06/2019 03:00	500	418	82	16%			31.40	30.72
18/06/2019 04:00	491	456	35	7%			30.63	31.32
18/06/2019 05:00	481	447	35	7%			30.00	31.04
18/06/2019 06:00	485	450	36	7%			29.70	31.46
18/06/2019 07:00	512	462	50	10%			30.87	32.40
18/06/2019 08:00	516	470	46	9%			31.97	34.87
18/06/2019 09:00	540	477	62	12%			33.81	37.52
18/06/2019 10:00	587	466	121	21%			36.95	41.48
18/06/2019 11:00	595	492	103	17%			39.52	46.57
18/06/2019 12:00	584	473	111	19%	88%	77%	42.07	45.03
18/06/2019 13:00	590	470	120	20%			39.12	40.57
18/06/2019 14:00	610	475	135	22%			37.88	37.73
18/06/2019 15:00	654	614	40	6%			36.57	37.77
18/06/2019 16:00	655	614	41	6%			35.74	37.29
18/06/2019 17:00	653	568	85	13%			35.22	36.56
18/06/2019 18:00	636	539	97	15%			34.18	36.03
18/06/2019 19:00	624	523	101	16%			33.73	36.63
18/06/2019 20:00	632	524	108	17%			34.29	36.89
18/06/2019 21:00	610	511	99	16%			34.25	37.63
18/06/2019 22:00	521	479	42	8%			33.83	37.69
18/06/2019 23:00	509	475	34	7%			33.60	37.61
Day Total	13533	11673	1860	14%				

Date	Total chiller consumption in KWh with Smart Cooling™ OFF 19 June	Total chiller consumption in kwh with Smart Cooling™ ON 5 June	Savings in kwh	Savings in %	Chiller load with Smart Cooling™ OFF	Chiller load with Smart Cooling™ ON	Temperature with Smart Cooling™ OFF 19 June	Temperature with Smart Cooling™ ON 5 June
19/06/2019 00:00	561	428	133	24%			33.88	37.42
19/06/2019 01:00	586	425	161	27%			34.43	36.78
19/06/2019 02:00	558	427	131	24%			34.69	36.12
19/06/2019 03:00	526	434	95	18%			34.52	35.29
19/06/2019 04:00	510	468	42	8%			34.24	34.85
19/06/2019 05:00	500	446	54	11%			33.93	34.53
19/06/2019 06:00	500	448	52	10%			33.65	34.61
19/06/2019 07:00	519	457	62	12%			33.84	35.68
19/06/2019 08:00	575	472	104	18%			34.27	36.73
19/06/2019 09:00	558	474	83	15%			35.35	38.78
19/06/2019 10:00	577	467	110	19%			37.23	41.86
19/06/2019 11:00	597	482	115	19%			41.03	46.33
19/06/2019 12:00	635	388	247	39%	85%	85%	42.99	48.59
19/06/2019 13:00	644	414	230	36%			40.22	46.39
19/06/2019 14:00	621	429	193	31%			37.99	39.16
19/06/2019 15:00	634	560	74	12%			36.52	37.80
19/06/2019 16:00	635	528	107	17%			35.48	36.60
19/06/2019 17:00	637	525	112	18%			34.55	36.06
19/06/2019 18:00	636	531	105	17%			33.70	35.35
19/06/2019 19:00	589	517	72	12%			32.99	34.74
19/06/2019 20:00	578	451	128	22%			32.92	34.95
19/06/2019 21:00	571	383	189	33%			32.89	35.40
19/06/2019 22:00	524	377	148	28%			32.51	35.69
19/06/2019 23:00	493	405	89	18%			32.25	35.43
Total of day	13769	10933	2836	21%				

Date	Total chiller consumption in KWth with Smart Cooling™ OFF 20 June	Total chiller consumption in kwh with Smart Cooling™ ON 6 June	Savings in kwh	Savings in %	Chiller load with Smart Cooling™ OFF	Chiller load with Smart Cooling™ ON	Temperature with Smart Cooling™ OFF 20 June	Temperature with Smart Cooling™ ON 6 June
20/06/2019 00:00	537	377	160	30%			32.44	35.13
20/06/2019 01:00	527	353	173	33%			32.29	34.91
20/06/2019 02:00	516	347	169	33%			32.04	34.61
20/06/2019 03:00	504	337	167	33%			31.63	33.84
20/06/2019 04:00	490	424	67	14%			30.97	33.77
20/06/2019 05:00	495	400	95	19%			30.49	33.79
20/06/2019 06:00	497	399	98	20%			30.58	32.43
20/06/2019 07:00	485	411	74	15%			31.85	33.89
20/06/2019 08:00	530	451	79	15%			33.56	35.83
20/06/2019 09:00	613	516	97	16%			35.50	38.44
20/06/2019 10:00	613	508	105	17%			38.41	41.89
20/06/2019 11:00	647	507	141	22%			43.42	47.04
20/06/2019 12:00	712	509	203	29%	88%	79%	45.52	45.52
20/06/2019 13:00	731	512	219	30%			43.53	39.53
20/06/2019 14:00	709	501	209	29%			38.16	38.01
20/06/2019 15:00	693	556	137	20%			36.75	36.37
20/06/2019 16:00	690	568	122	18%			35.89	35.29
20/06/2019 17:00	686	554	132	19%			35.57	34.63
20/06/2019 18:00	674	527	148	22%			34.91	33.86
20/06/2019 19:00	691	510	181	26%			34.15	33.71
20/06/2019 20:00	733	517	216	30%			33.65	33.71
20/06/2019 21:00	728	475	253	35%			33.71	33.97
20/06/2019 22:00	625	423	202	32%			33.65	34.26
20/06/2019 23:00	580	410	170	29%			33.21	34.15
Day Total	14707	11091	3616	25%				

Date	Total chiller consumption in KWh with Smart Cooling™ OFF 21 June	Total chiller consumption in kwh with Smart Cooling™ ON 7 June	Savings in kwh	Savings in %	Chiller load with Smart Cooling™ OFF	Chiller load with Smart Cooling™ ON	Temperature with Smart Cooling™ OFF 21 June	Temperature with Smart Cooling™ ON 7 June
21/06/2019 00:00	658	433	224	34%			33.22	33.76
21/06/2019 01:00	609	400	209	34%			33.27	33.29
21/06/2019 02:00	607	405	201	33%			33.38	32.99
21/06/2019 03:00	602	351	251	42%			32.96	32.49
21/06/2019 04:00	670	424	245	37%			33.03	32.77
21/06/2019 05:00	599	380	218	36%			33.61	32.12
21/06/2019 06:00	568	391	178	31%			33.78	31.66
21/06/2019 07:00	578	378	200	35%			34.51	33.10
21/06/2019 08:00	601	449	152	25%			35.73	35.08
21/06/2019 09:00	628	492	135	22%			37.63	38.14
21/06/2019 10:00	729	423	307	42%			40.30	39.04
21/06/2019 11:00	722	464	258	36%	74%	68%	41.61	41.30
21/06/2019 12:00	753	467	316	40%			41.64	41.52
21/06/2019 13:00	780	459	321	41%			38.43	38.99
21/06/2019 14:00	768	494	275	36%			38.87	38.35
21/06/2019 15:00	716	482	233	33%			35.55	36.88
21/06/2019 16:00	758	475	283	37%			34.98	35.90
21/06/2019 17:00	626	490	136	22%			34.57	35.29
21/06/2019 18:00	632	444	188	30%			34.27	34.26
21/06/2019 19:00	635	432	203	32%			34.02	34.30
21/06/2019 20:00	730	426	304	42%			34.05	35.04
21/06/2019 21:00	620	419	201	32%			33.96	35.29
21/06/2019 22:00	502	347	155	31%			33.81	35.01
21/06/2019 23:00	499	354	145	29%			33.69	34.69
Day Total	15619	10280	5339	34%				
PERIOD TOTAL	**70112**	**53386**	**16726**	**24%**				

Test 2: 30-day Summary

Test No.2 was carried out for the period of 30 days, between 31 May and 30 June 2019. During this period, the chillers' electricity consumption was calculated with *Smart Cooling*™ turned ON.

The **Carrier 30XA 1002** chillers operated with the *Smart Cooling*™ unit **ON** for consecutive 20 days, during when the total energy consumption of the chillers' MW/h was measured.

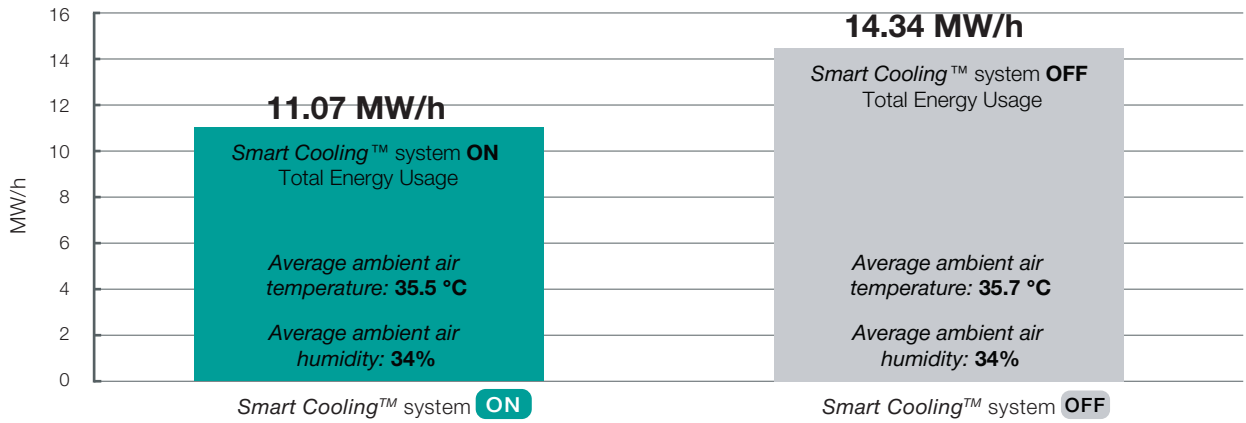
Measured consumption with *Smart Cooling*™ **ON**
Smart Cooling™ equipment was **ON** for 20 days with an average hotel occupancy of **72%**. In 20 days, total chiller consumption was of **221.41 MW/h**, an average of **11.07 MW/h** per day.

- **Formula**: *(221.41 MW/h ÷ 20 days) = 11.07 MW/h* on a 24-hour average.

Measured consumption with *Smart Cooling*™ **ON**
Smart Cooling™ equipment was **OFF** for 9 days with an average hotel occupancy of **82%**. In 9 days, total chiller consumption was of **129.06 MW/h**, an average of **14.34 MW/h** per day.

- **Formula**: *(129.06 MW/h ÷ 9 days) = 14.34 MW/h* on a 24-hour average.

Test Nr. 2 summary:
After a 30-day, 24-hour comparison test of average electricity consumption of a **Carrier 30XA1002**, we ascertained that average savings were of **2 to 3 MM/h**, contingent on the hotel's occupancy rate. Total 30-day water consumption, including *Smart Cooling*™ maintenance was **375 m³**.



Test 2

30-day overview with Smart Cooling™ turned ON and OFF

Smart Cooling™ Water and Electricity Consumption Readings								
Date	Previous water consumption in m³	Current water consumption in m³	Total Consumed	Total Mwh consumed	OCCP %	Smart Cooling™ operational notes	Average ambient air temperature	Highest ambient air temperature
31/05/2019	0	38	7918.56	8.77	47.08	On - final adjustments performed	34	43
01/06/2019	38	50	3079.44	8.25	47.08	on	34	40
02/06/2019	50	60	2199.6	8.43	47.08	on	34	43
03/06/2019	60	78	3959.28	9.41	54.04	on	33	39
04/06/2019	78	95	3739.32	11.67	57.94	on	36	46
05/06/2019	95	112	3739.32	10.93	76.32	on	37	46
06/06/2019	112	130	3959.28	11.09	83.29	on	37	47
07/06/2019	130	148	3959.28	10.28	77.44	on	35	41
08/06/2019	148	162	3079.44	9.92	66.02	on	35	45
09/06/2019	162	175	2859.48	10.43	77.16	on	35	43
10/06/2019	175	184	1979.64	11.36	81.82	on - after 14:00, one Smart Cooling™ circuit not operating	33	41
11/06/2019	184	197	2859.48	12.2	82.73	on - after 14:00, one Smart Cooling™ circuit not operating	35	42
12/06/2019	197	212	3299.4	12.27	86.07	on	37	44
13/06/2019	212	226	3519.36	12.13	93.31	on	37	44
14/06/2019	226	241	2859.48	12.46	88.86	on	36	44
15/06/2019	241	254	2859.48	12.54	77.16	on	35	43
16/06/2019	254	265	2419.56	12.54	86.35	on	35	42
17/06/2019	265	274	1979.64	12.48	84.96	At 17:00, Smart Cooling™ turned off	34	43
18/06/2019	274	274	0	13.53	86.35	off	34	43
19/06/2019	274	274	0	13.77	85.24	off	35	43
20/06/2019	274	274	0	14.71	88.02	off	35	45
21/06/2019	274	274	0	15.62	74.37	off	35	42
22/06/2019	274	285	2419.56	16.01	74.09	Off (cleaning process)	37	44
23/06/2019	285	294	1979.64	15.36	78.55	Off (cleaning process)	37	43
24/06/2019	294	294	0	13.58	83.84	off	36	44
25/06/2019	294	294	0	12.96	83.29	off	35	43
26/06/2019	294	294	0	13.52	86.91	off	37	42
27/06/2019	294	309	3299.4	12.82	85.79	On, after 15:00	37	44
28/06/2019	309	332	5059.08	12.58	79.67	on	37	44
29/06/2019	332	355	5059.08	12.03	71.03	on	38	48
30/06/2019	355	375	4399.2	11.83	76.32	on	37	47

ROI Summary:

Calculated savings:

- Daily electricity savings = 2.5 Mw/h X 0.45 AED (energy supply rate) = **AED 1,125**.
- Monthly electricity savings = AED 1,125 X 30 days = **AED 33,750**.

Operation costs:

- Monthly water consumption = 375 m3 X 10 AED (water supply rate) = **AED 3,750**.
- Biochemical materials and maintenance costs = **AED 600**.
- Total operational costs = **AED 4,350**.
- Monthly net savings = AED 33,750 - AED 4,350 = **AED 29,400**.

Equipment costs:

- 2 Smart Cooling™ devices = **AED 210,000** *(Inc. VAT)*

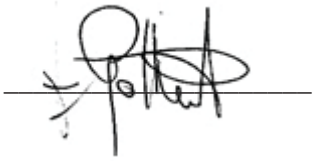
Return on Investment (ROI):

- 2 Smart Cooling™ devices= 210,000 / (29,400 X 8) = **10.7 Months**

ROI Calculation Notes:
There are effectively eight operating months comprising heat season and four months with negligible savings, which were not considered for the purposes of this ROI calculation.

As per the readings above, measured savings range from **2 to 3 MW/h** per day. For estimation purposes, we have based the ROI calculation on average savings of **2.5 MW/h**.

ROI calculation is contingent on a building's cooling requirements and external air temperature).

Luca Gallarate 
31 July 2019

Annex:

Riels instruments srl
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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