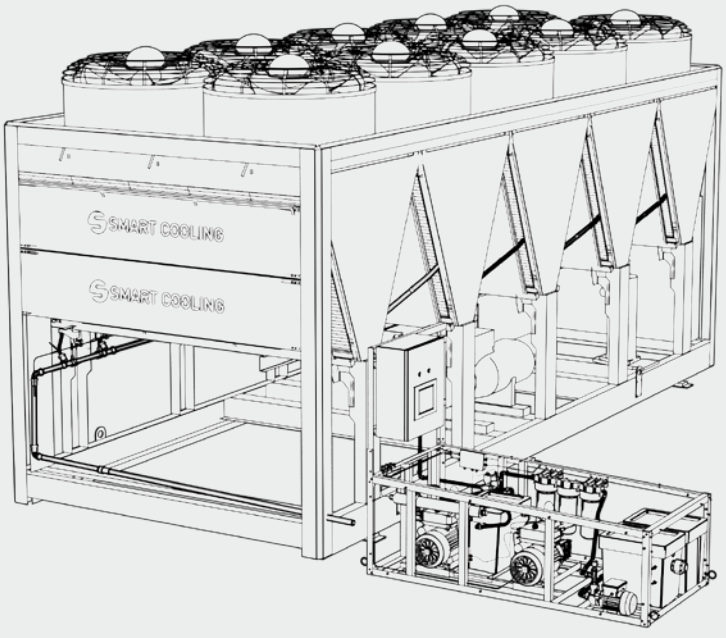
16 December 2017

TEST REPORT
006



SMART COOLING™ PRO10 SYSTEM

Data center Vodafone Group Plc

Test Participants:
Project name: **VODAFONE DATA CENTER** Location: **Alfragide, Portugal**
Customer: **VODAFONE GROUP PLC**
Engineer: **Claudio Romaneto**
Swiss Integrated Energy Technologies: **Luca Gallarate**

Table of Contents

Introduction:

Type of structure: Vodafone Data Center, Alfragide, Portugal.
Cooling units: Air cooled water chiller **TRANE Model 39CA538.01.**
Chiller booster: *Smart Cooling™ PRO 10*, adiabatic technology with condenser protection (BY70).

Chillers were retrofitted with the intelligent adiabatic *Smart Cooling™* system to reduce their electricity consumption and increase COP (Coefficient of Performance) efficiency.

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.

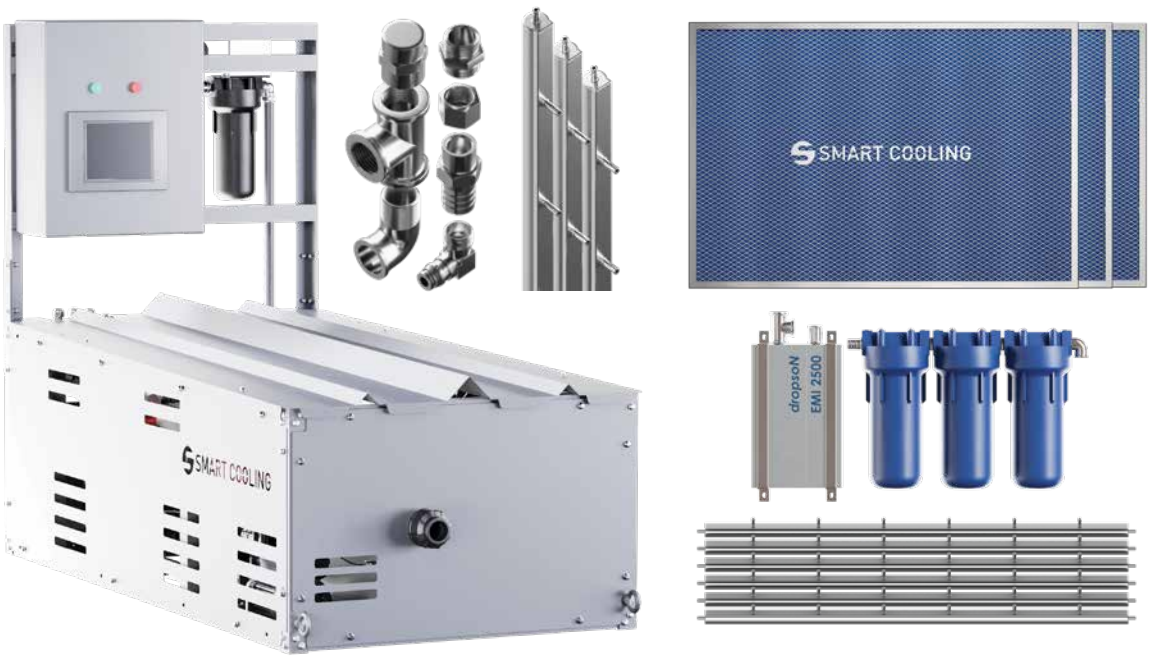
Before installation

After installation

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:

All measurements were recorded using Vodafone's internal monitoring and data analytics infrastructure, which tracked thermo-hygrometric conditions and chiller electrical absorption throughout the test periods.

Data sources included:

- Chiller performance parameters
- Electrical absorption (kWh)
- Energy usage during **OFF** and **ON** periods

Outdoor environmental measurements:

- Air temperature (°C)
- Relative humidity (%RH)

Measurements were collected continuously throughout the two test cycles:
24–27 July 2017 — Smart Cooling™ **OFF**
28–31 July 2017 — Smart Cooling™ **ON**

The monitoring system ensured consistent data acquisition for accurate period-to-period and point-on-point comparison.

Equipment involved in data collection:

- Vodafone Data Analytics Platform
- Temperature and humidity monitoring sensors
- Energy absorption logging from **TRANE chiller Model 39CA538.01**

Testing *Smart Cooling*™**:**

Step 1 — Installation of data logging equipment
Smart Cooling™ BY70 was installed on the air-cooled **TRANE 39CA538.01** chiller at Vodafone Data Center (Alfragide, Portugal). The installation and test were overseen by Vodafone Italia and Swiss Integrated Energy Technologies.

Step 2 — Test Periods
Two consecutive 4-day periods were selected to keep conditions comparable:
- OFF: 24–27 July 2017;
- ON: 28–31 July 2017.

Data points with ambient T **< 24°C** were excluded (system inactive below 24°C).

Step 3 — Measurements & Instrumentation
Continuous logging of chiller electrical absorption (kWh), air temperature (°C) and relative humidity (RH) was performed via Vodafone's analytics platform and site sensors. Point-on-point matches were taken where thermo-hygrometric conditions were equivalent.

Step 4 — Analysis Method
- Point-on-point comparisons: matched timestamps with similar T/RH between OFF and ON periods to compute instantaneous savings.
- Period-on-period comparison: summed 4-day energy for each period and excluded readings when T < 24°C to ensure fair comparison.

Step 5 — Key Results
- **Point savings examples:**
- 25°C - 21.11%,
- 30°C - 27.10%,
- 35°C - 31.99% *(reduction in kWh)*
- **4-day totals:**
- OFF (24–27 Jul): **4,494,664 Wh**;
- ON (28–31 Jul): **3,504,837 Wh** → **989,827 Wh** saved (T ≥ 24°C).
- **Comparison:** ≈20.72 MWh saved (≈8%) over four months despite ~10% higher average temperature in 2017.

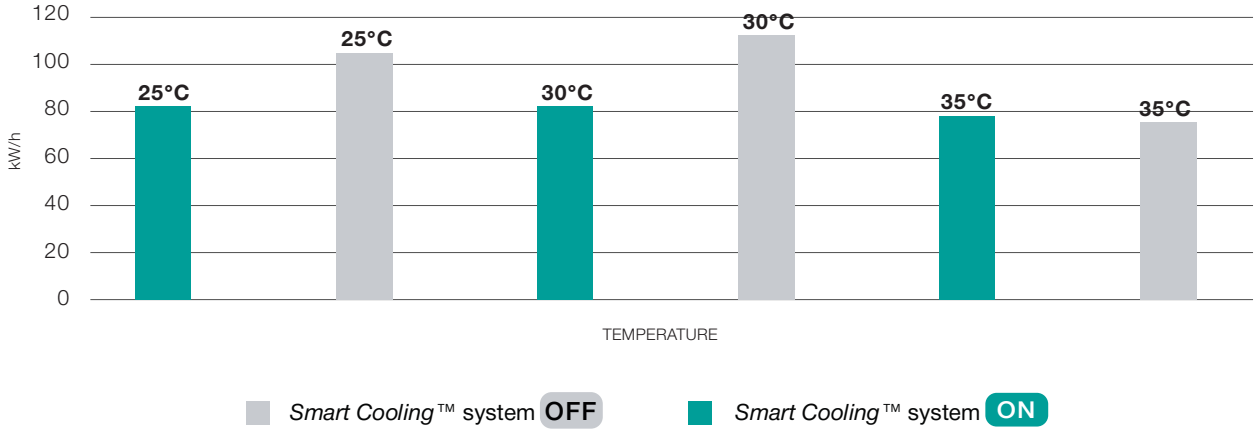
Testing Data:

In the two examined periods, points having the same thermo-hygrometric conditions were selected. As expected, the higher the temperature the better the system performs, with a peak of more than **30% saving at 35°C** (highest temperature recorded).

Temperature (°C)	Date	Time	RH (%)	Actual data	
				Energy absorption (kWh)	SAVING
25	24/07/2017 (SM OFF)	18:00	53,3	104,15	**21,11%**
	29/07/2017 (SM ON)	19:00	61,2	82,16	
30	25/07/2017 (SM OFF)	14:45	40,1	113,50	**27,10%**
	30/07/2017 (SM ON)	15:00	40,6	82,74	
35	25/07/2017 (SM OFF)	13:15	41,3	111,95	**31,99%**
	29/07/2017 (SM ON)	12:15	37,8	76,14	

Period-on-period comparison for the 4 days

June 24th to 27th, 2017 vs June 28th to 31st, 2017



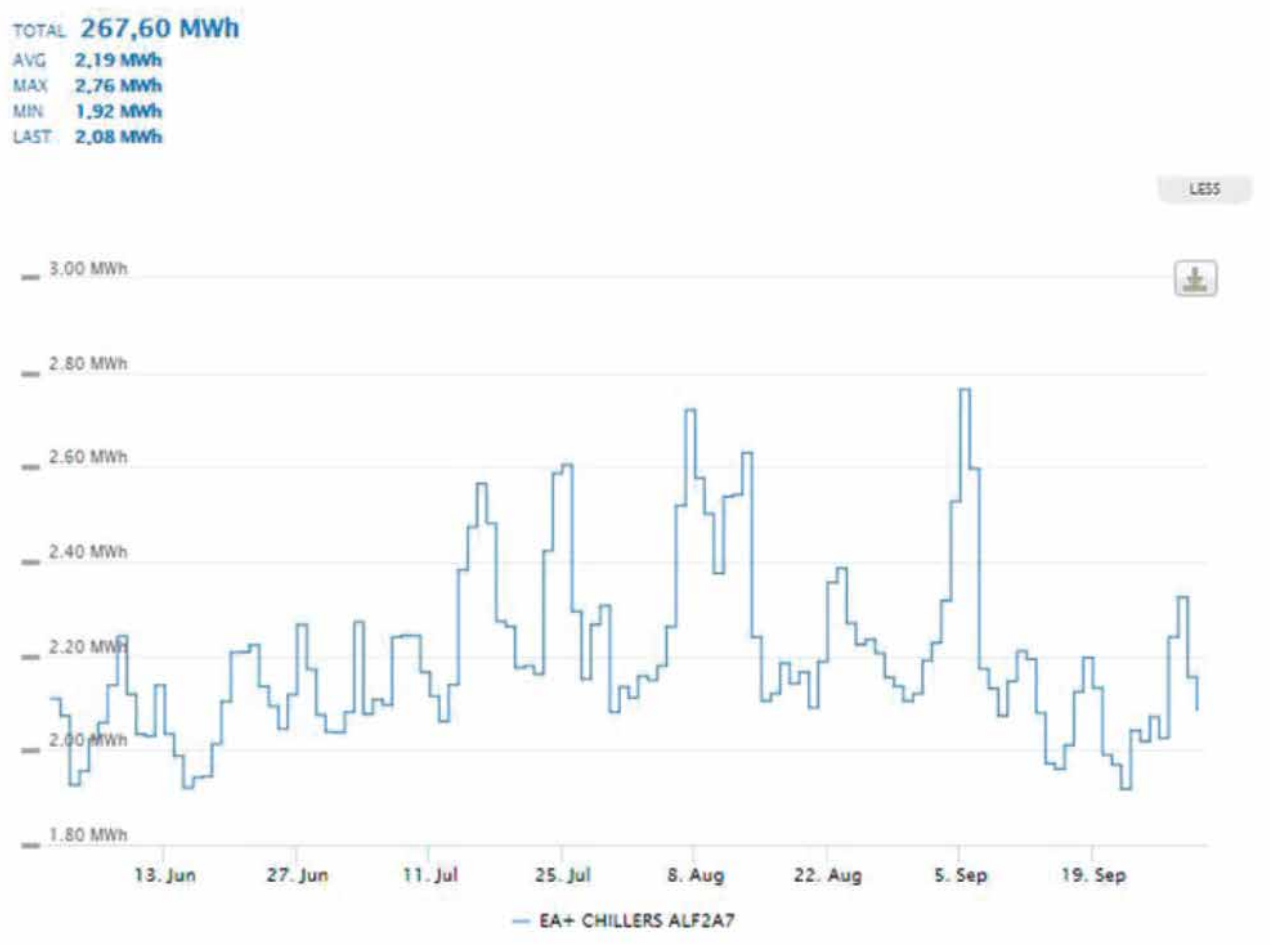
For the period-on-period comparison, the following data have been excluded:

- All absorption figures of the **OFF** chiller
- All absorption figures when T < 24°C (minimum threshold for the adiabatic system to start working)

- Total consumption from *July 24th to 27th, 2017* when *Smart Cooling™* **OFF**: **4.494.664 Wh**
- Total consumption from *July 28th to 31st, 2017* when *Smart Cooling™* **ON**: **3.504.837 Wh**

Period-on-period comparison for the 4 days

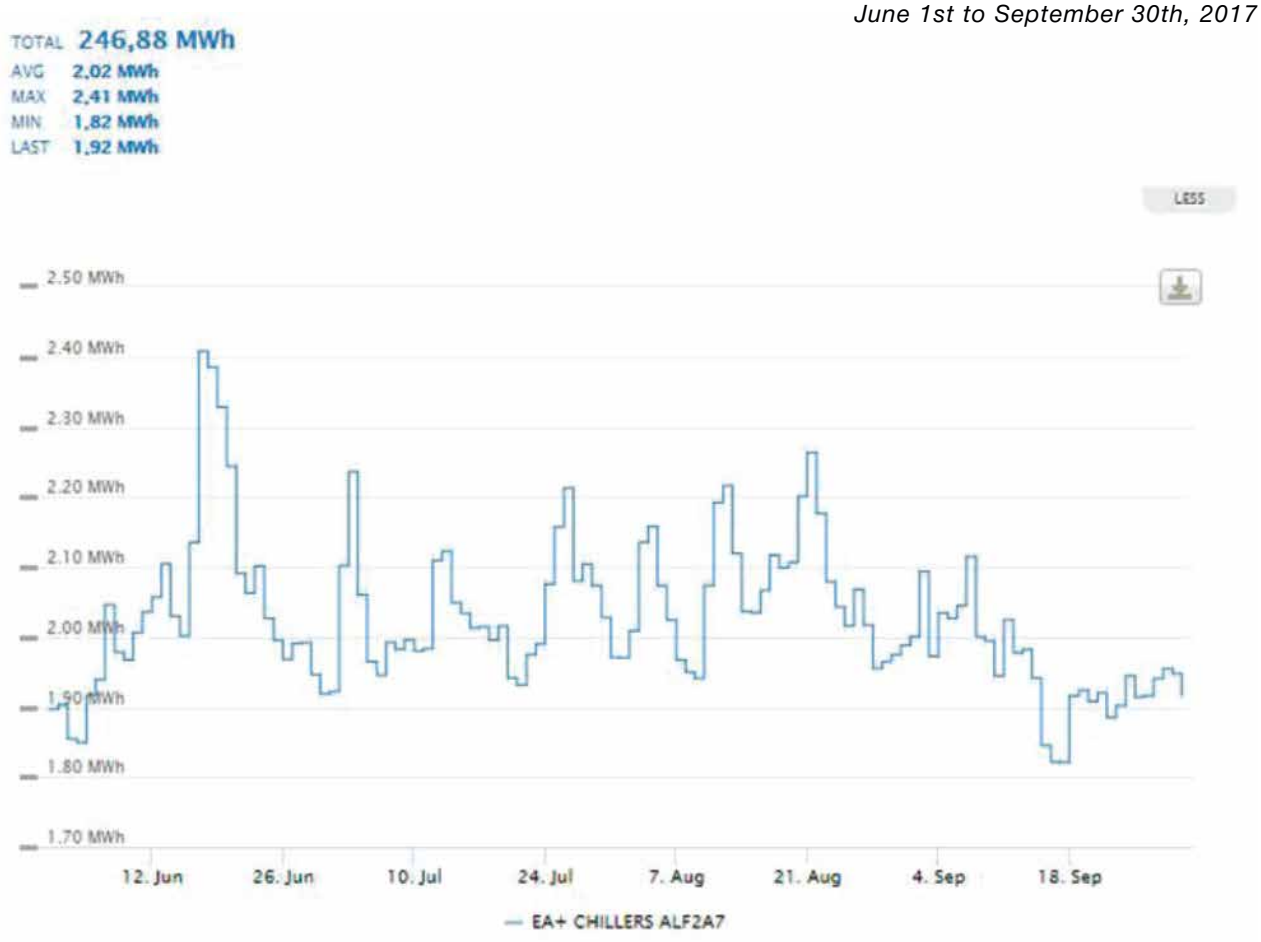
June '16 – Sept '16 vs June '17 – Sept '17



The table reports the data on absorption from *June 1st to September 30th, 2016*, when SM system was **OFF**

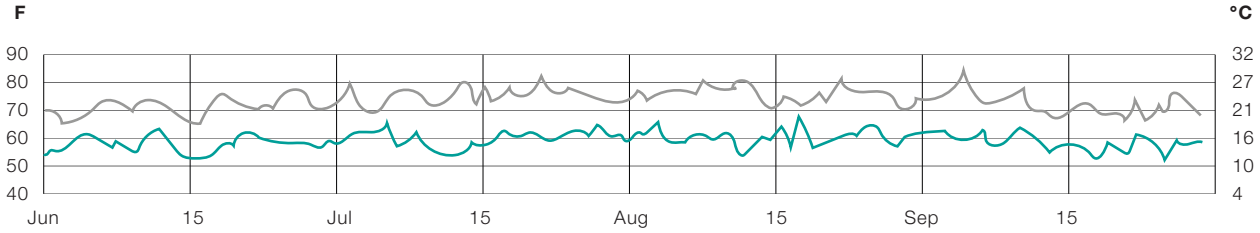
Period-on-period comparison for the 4 days

June 1st to September 30th, 2017

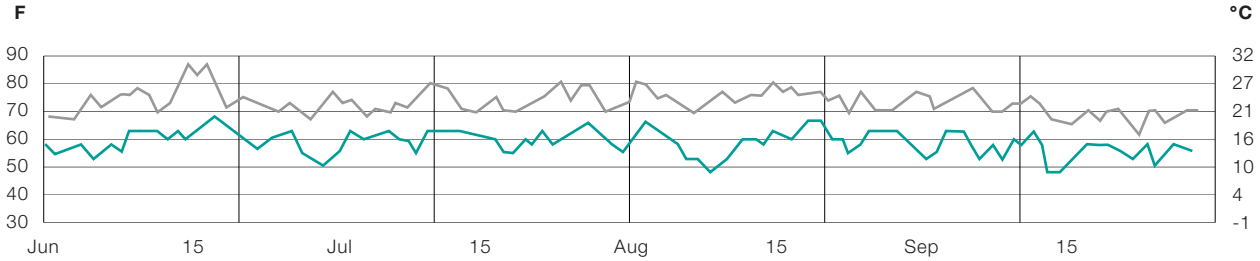


The following table reports the absorption from June 1st to September 30th, 2017, with SM system **ON**

Average temperature in Lisbon
2016



Average temperature in Lisbon
2017



Temperature *Dew Point*

By comparing the data about the two June–September periods, it results that the saving achieved was **20.72 MWh (8%)**, despite the average temperature in the period June–September 2017 being 10% higher. Another important finding is that with the *Smart Cooling*™ system energy absorption never crossed **2.41 MWh** between June and September 2017, while in the same period in 2016 – without *Smart Cooling*™ – such value had been often crossed, with peaks of **2.76 MWh**.

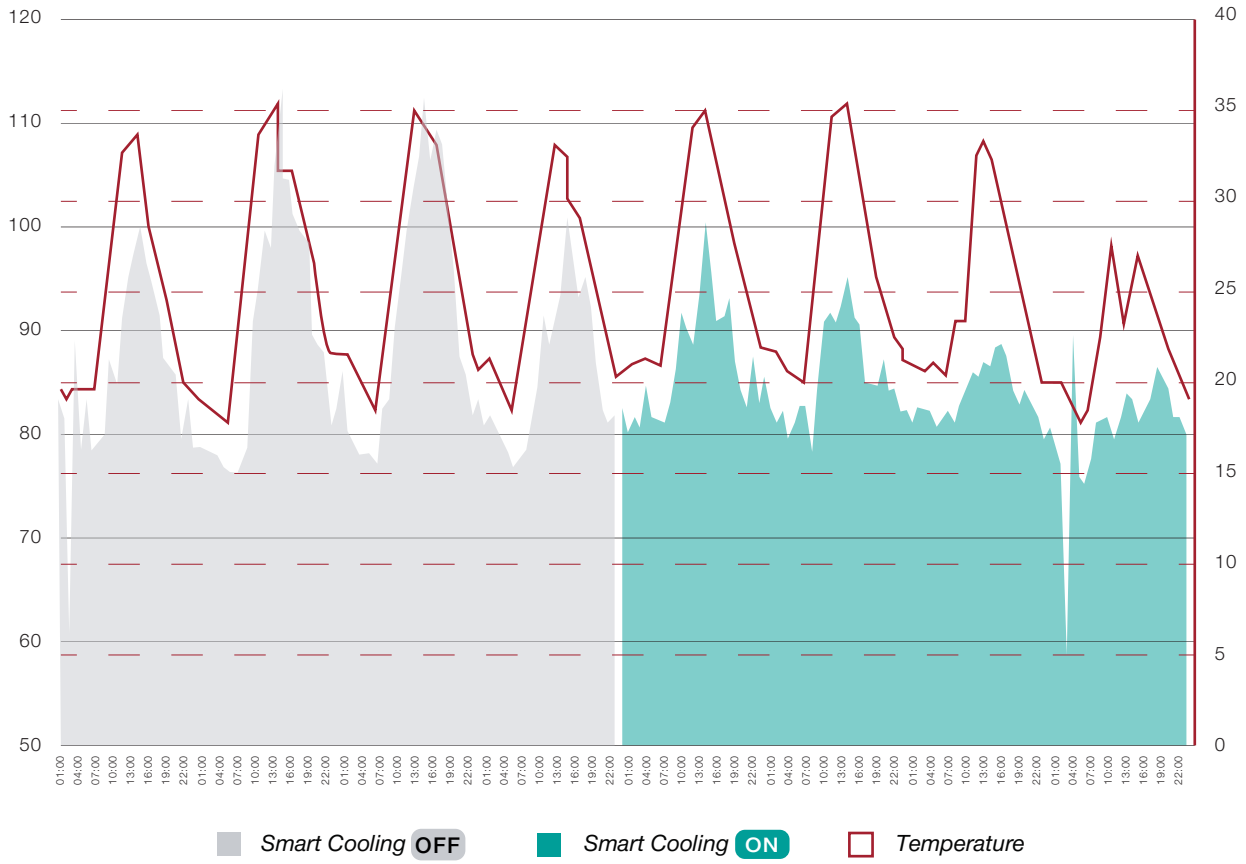
Year	Consumption MWh	Average MAX temperature	Hours with T >24°
2016 SM OFF	267,60	29	484
2017 SM ON	246,88	31	403
Saving	**20,72**		

Test results:

Comparison has been carried on by recording data on air temperature, relative humidity and energy absorption of the chillers for two 4-day periods:

- From *July 24th to 27th, 2017*, with the *Smart Cooling*™ system **OFF**
- From *July 28th to 31st, 2017*, with the *Smart Cooling*™ system **ON**

Similar thermo-hygrometric conditions over the two periods make the comparison reliable. The graph shows that, with comparable thermo-hygrometric conditions, *Smart Cooling*™ allows for a remarkable decrease in energy absorption of the chiller.



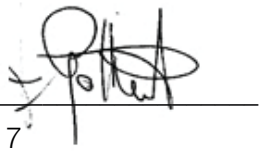
Conclusion:

The *Smart Cooling*™ system demonstrated consistent energy savings on the Vodafone data center chiller under comparable operating conditions. Seasonal data (June–September) confirms a total saving of **20.72 MWh**, achieved despite 10% higher ambient temperatures in 2017. Smart Cooling™ also kept daily energy absorption below **2.41 MWh**, whereas in 2016—without the system—values frequently exceeded this threshold, reaching peaks of **2.76 MWh**.

Analysis identified several factors influencing ROI, including oversized chiller capacity, condenser fan control prioritizing noise reduction, and independent *Smart Cooling*™ installations on each chiller. Despite these constraints, the system still delivered measurable improvements.

To further increase efficiency, the following optimizations are recommended:
Lower the fan activation threshold to **26°C** instead of 35°C.
Reduce water spray volume by **28%** through microprocessor adjustments.
Adjust the chiller rotation schedule to six-month intervals to balance compressor wear.

With these improvements, an additional **40% efficiency gain** can be achieved, further enhancing the performance of the chiller + *Smart Cooling*™ system.

Luca Gallarate 
December 16, 2017