EuroHeat & Power First Global
District Energy Awards

Application

The IBM industrial & technology park cooling and heating network at Montpellier (France)

Paris, September 25, 2009

Introduction

In 1994, IBM decided upon a Facilities Management contract to outsource building services. It sought a partner that would take a close look at its entire site to:

- increase the capacity of its servers housing at its Montpellier Products and Solutions Support Center,
- carry out a true energy efficiency policy review, and
- establish performance indicators to track policy implementation.

With Cofely*, IBM entirely stripped down its room air conditioning procedures,

- analyzing and configuring its seasonal heating and cooling needs,
- reviewing temperature level and
- installing real-time monitoring of various users' needs.

The objective was to obtain increased energy yields and overall savings in electricity, natural gas, and water consumption.

In the end, strategic investment choices led to:

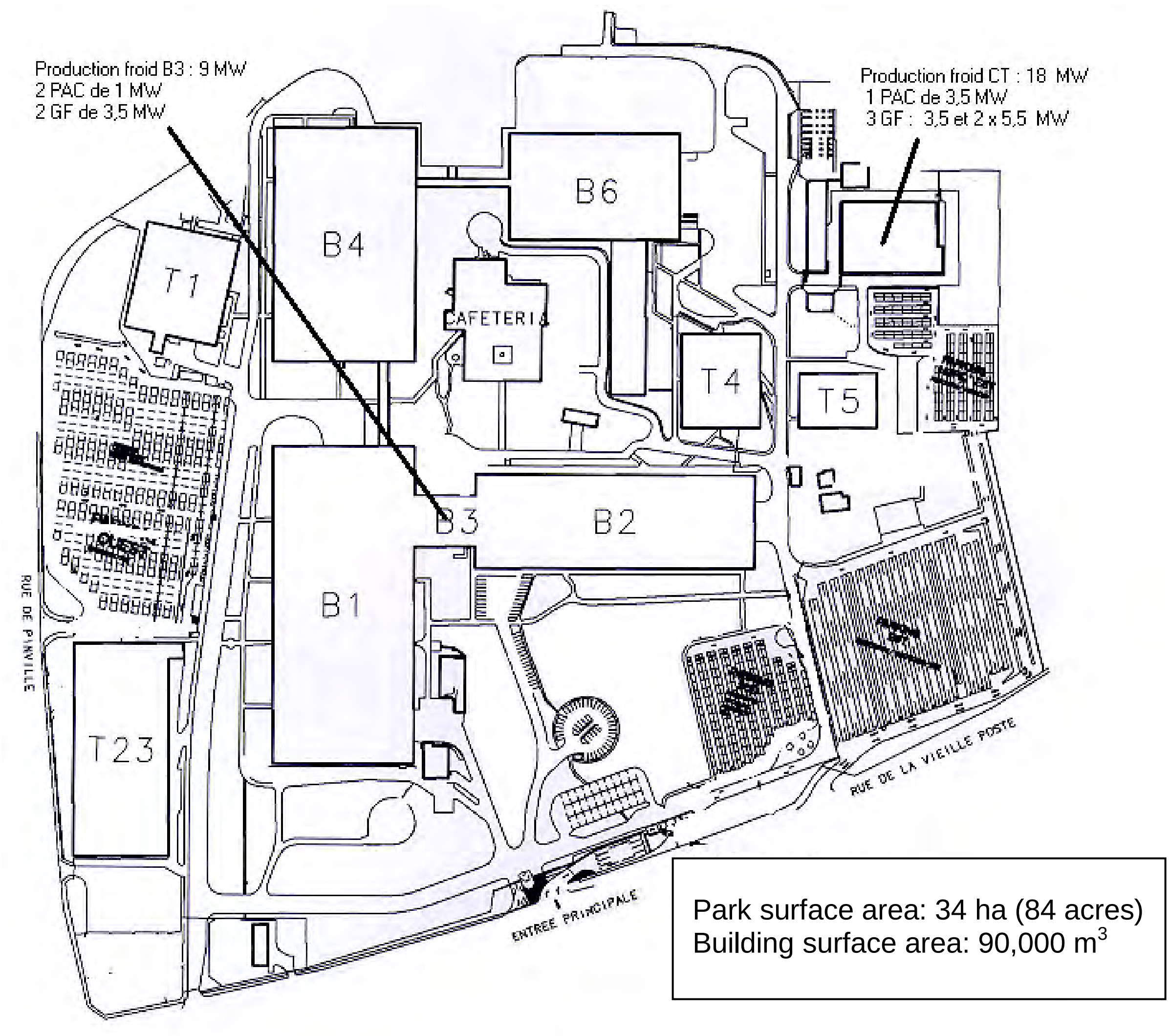
- complete elimination of natural gas consumption at the site,
- a 50% reduction in the quantity and quality of process water,
- drastic reduction of the risk of Legionella from cooling towers,
- a 15% improvement in the facility's overall COP,
- a more than 85% reduction in the facility's carbon footprint,
- a PUE (*Power Usage Effectiveness*) measurement protocol based on a CYLERGIE** research program.

A network solution was therefore decided for the Pompignane industrial technology park.

** Cofely was created with the merger of Elyo and Cofathec. Originally, Elyo was the contract beneficiary.*

***.Cylergie stands for Centre de Recherches de la Branche Energie Services de GDF SUEZ (GDF SUEZ Energy Services Business Line Research Center).*

Site overview



Two thousand employees work at the Pompignane Industrial and Technology Park, 1,000 of whom for IBM.

- The IBM employees are mainly engaged in assembling computer servers and data storage and processing operations.
- The remainder of the site (30,600 m^3) is mainly service-oriented, plus a smart card manufacturing operation and warehouses for dispatching IBM servers.

The server computer rooms require constant cooling to maintain the low temperatures necessary for the machines. Cooling and heating is also needed to provide personnel comfortable working conditions.

The IBM situation

Cooling was produced by two technical centers equipped with water chillers with water condensers functioning with open-type air cooled condensers.

The main technical center was equipped with 14.5 MW total cooling power water chillers (two chillers of 5.5 MW each plus a 3.5 MW heat pump). The second technical center, named B3, was equipped with a water chiller with 5.5 MW total cooling power (one 3.5 MW chiller plus two 1 MW heat pumps).

The heating function was supported by the heat pumps and 3 older boilers (more than 30 years old) with heating power totaling 12 MW. Two pipe networks (90° and 45°) distributed heat to the site.

To ensure current and future levels of energy essential to site activities, it became necessary to modernize and build up the technical center's production resources.

Selected objectives

- Cooling and heating for 10 years (with site expansion if necessary);
- 99.99% chilled water reliability for the data centers alone, not counting electrical failures;
- Cooling power 17.8 MW;
- Dry mode operations at a 4.5 MW minimum to guarantee cooling for strategically important rooms, including during Legionella crisis periods;
- Heating power 4.6 MW;
- N+1 redundancy for all energy producing plants for the data centers; and
- Ensuring compliance with new regulations.

Of course, these objectives were to be achieved under acceptable economic conditions and without plant shutdowns.

A suitable technical solution

1/ Centralize the production facilities at one single point, keeping existing cold production facilities that are in compliance and in good condition,

2/ Install air-cooled refrigerated units,

3/ Install heat pumps for integrated heat and cold production,

4/ Boost cold production by setting up a new centrifuge unit,

5/ Replace the cooling towers with hybrid towers,

6/ Implement water treatment by osmosis to work with the new towers,

7/ Renovate heat production using a boiler equipped with a condensate collector and create a network to link the boiler room with the technical center,

8/ Provide customized metering and billing,

9/ Optimize operations with Building Monitoring System.

1/ One single technical center

(End of relocation work: November 2007)

- Optimize the number of machines in service (vastly improved cascade both for refrigerated units and wet cooling towers);
- Reduce the quantity of equipment and links between towers and chillers;
- Simplify the electrical backup system; and
- Optimize maintenance.

Recovered equipment
Carrier brand centrifugal chiller
3500 kW

2/ Three air-cooled condenser units:
(Brought online in 2004)

- Operates in winter to supplement the heat pumps;
- Very high winter COP;
- No Legionella risk, guaranteed "dry" mode of operation; and
- Simplified maintenance and operation.

Air-cooled condenser unit

To eliminate any risk of Legionella from the production required for the Data Center, we installed 3 Trane brand RTAC air-cooled units with a cooling capacity of 1600 kW per unit.

We paid special attention to reducing sound pollution (low-speed units and a noise protection screen).

3/ Three heat pumps
(Brought online in November 2007)

- Operation in "heat" mode prioritized in the winter; energy is recovered from the condenser to be injected into the heating network, and cold is recovered from the evaporator for air conditioning in the computer rooms,
- Overhand of some units (to make secure),
- Reduction of gas consumption and therefore CO_2 emissions.

Trane heating pump (heating capacity: 1120 kW / cooling capacity: 920 kW)

We installed 3 Trane brand RTHD heating pumps with a per-unit heating capacity of 1120 kW (water at 50°C) and cooling capacity of 920 kW (water at 6°C/11°C).

This equipment, equipped with screw compressors, runs on R134a.

4/ New air cooled condensers
(Brought online in June 2007)

- Restoration of the entire cooling capacity of the refrigerated units to like-new condition.
- Repair of the structure (solidity and aesthetics).
- Operation in "dry" mode nearly 50% of the time (sharply reduces consumption of water and water treatment products, zero risk of Legionella during the "dry" operations period).
- Option of functioning in "dry" mode in the summer using the heat pumps.
- Reduction of noise pollution.

BALTIMORE air cooled condensers

Installation of this new equipment brought the site into compliance with requirements on noise emissions and helped to limit the quantity of water used and discharge into the sewer system.

5/ Reverse osmosis treatment of cooling tower water: a first in France for cooling networks (Brought online in June 2007)

- Reduction of water consumption.
- Reduction of the quantity of chemical products used.
- Reduction of operating costs.
- Reduction of discharge into the sewer system.

Reverse osmosis water treatment

To supply the wet cooling towers, we used water from the "BRL" network, which is generally used for watering plants and not used for human consumption.
This water has a very high level of solid particles with an extremely alkaline pH. In order to be able to use this water in the towers, we set up a treatment comprising sand filtration followed by UV disinfection and finally a dialyzer with a capacity of 30 m^3/hour at 15°C, made up of 6 CodeLine pressure vessels (part number 80A45-6W) containing 32 ESPA 1 polyamide membranes.

Using industrial water instead of drinking water offers a better economic result and reduced environmental footprint.

6/ A higher performance cooling unit
(Brought online in June 2007)

- Secure production
- Improved performance
- Reduced operating costs

Trane centrifugal chiller with a capacity of 3600 kW

A Trane brand CVGF 1000 centrifugal chiller with a capacity of 3600 kW was installed (with a 5500 V engine to reuse the existing power supply).

This equipment operates only during the summer period, and it was therefore chosen for its performance under high temperature conditions.

The equipment is connected to the network of dry cooling towers from the condenser side.

The objective is to reduce operations that use air-cooled units during the summer period because of their very low COP when operating in high outside temperatures.

7/ A new custom boiler
(Brought online in January 2007)

- Secured production
- Improved performance
- Reduced operating costs

Viessmann boiler equipped with a condensate collector

We installed a Viessmann brand Vitomax 300 boiler with a capacity of 2300 kW, equipped with a Vitotrans 333 condensate collector and a Weishaupt brand gas burner equipped with a variable speed drive controlled by an oxygen detector in the flue gas.

This equipment is used to complement the heat pumps. The network at 45°C is very conducive to operating this type of equipment.

Utilization is very low (zero as of now), because the equipment is only scheduled to operate during very cold weather or if production from the heating pumps fails. The heating network that supplied the substations directly was modified and adapted.

8/ Metering

(Brought online in January 2007)

We installed a set of thermal energy meters required to bill each user. All customers in the region (Geodis, Sagem, etc.) are billed individually based on their consumption.

All metering information is reported to the supervision center via fiber optics.

9/ Setting up Monitoring System

(Brought online in December 2007)

- Optimized starting/stopping of machines

  (The machine with the best performance is started each time needs increase, and conversely, the machine with the lowest yield is stopped each time needs decrease)

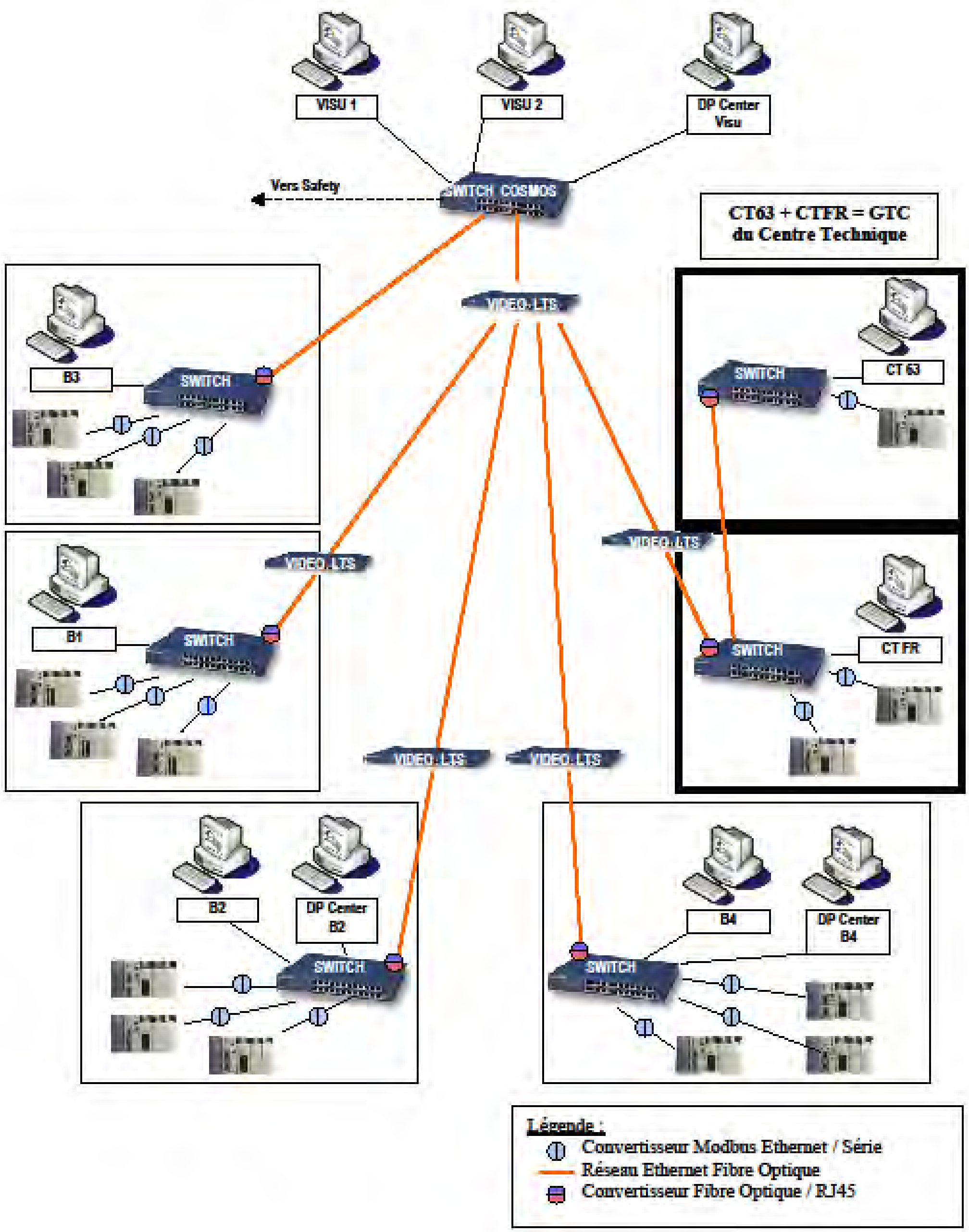
- Reduced operating costs

- Improved tracking of operations and maintenance

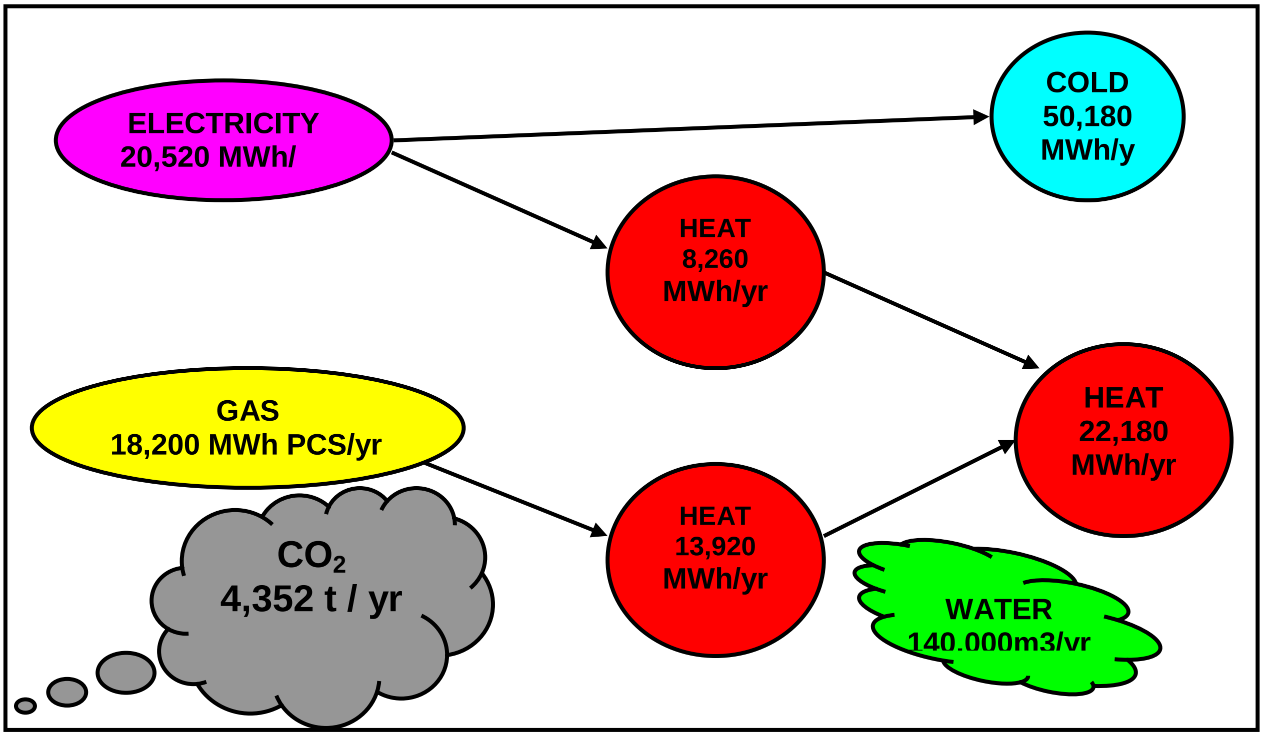
The monitoring system architecture is composed of:

- A cold production supervision center located in the control room of the central building and communicating with the main operating center over the MUSE token ring network;
- An automated production management system communicating with automated management of the cooling units;
- An automated system managing the wet cooling towers;
- A link-up with the automated systems managing the energy meters for billing chilled water across the entire network;
- Automated systems for the chillers and heat pumps;
- A central control panel connected directly to the automated systems and used to run the facilities in the case of a loss of supervision.

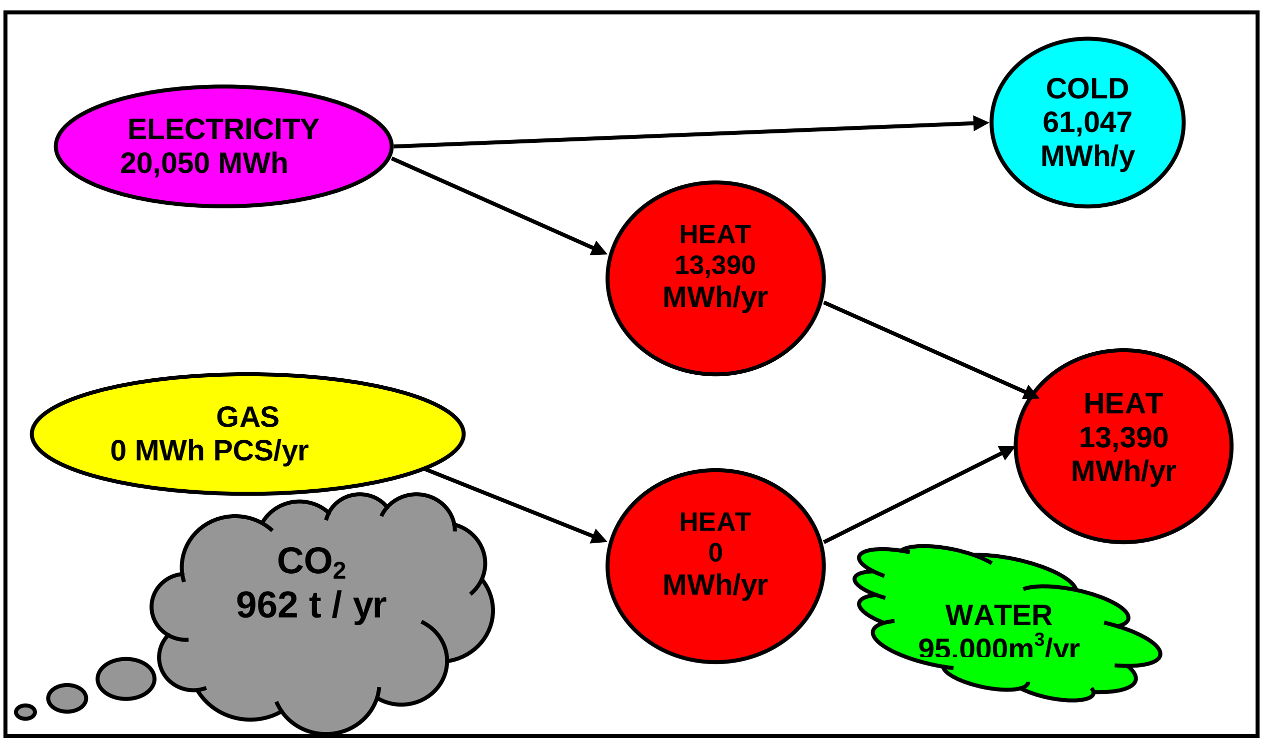
ARCHITECTURE DU RESEAU



PRE-PROJECT:



POST-PROJECT: the figures shown are based on an equivalent level of hosted computers. With Cofely's help, IBM was able to host more operating computers than in the past.



RESULTS

ELECTRICITY	**Sharp reduction from boosting performance by adding new equipment and optimizing machine starting.**
NATURAL GAS	**Almost all natural gas eliminated by substantially increasing recovery from the heating pumps.**
CO_2	**Significant drop due to the very large reduction in gas consumption.**
COLD	**Optimization of the consumption related to the site's activities.**
HEAT	**Network loss reduced by limiting initial temperatures. Regulation improvement and heat no-longer supplied in one of the buildings.**
WATER	***Very substantial drop in water consumption after installing new towers and reverse osmosis water treatment.***

IN FIGURES:

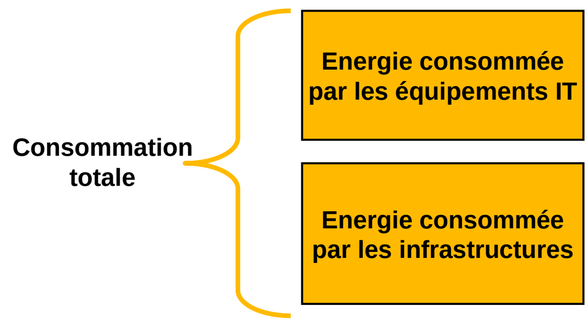
	BEFORE	AFTER	ABSOLUTE DELTA	RELATIVE
Electricity	20,520	20,050	470	down 2%
Natural gas	18,200	0	18,200	down 100%
Cold production	50,180	61,047	10,867	up 22%
Heat	22,180	13390	8,790	down 40%
COP	2.45	3.04		up 24%
Water	140,000	95,000	45,000	down 32%
CO2 (t/yr)	4,352	962	3,390	down 78%

10/ <u>Tracking indicator</u>

The measurement and tracking indicator generally used for datacenters is PUE (Power Usage Effectiveness).

A closer look at managing useful energy:

- Energy and environmental efficiency is evaluated by calculating the PUE of the technical infrastructures
- In a context of increasing computer density, it becomes more essential to optimize PUE.



$$\text{PUE} = \frac{\text{Conso totale}}{\text{IT}}$$

Protocol for measuring total PUE (simplified electrical distribution diagram of the data center)

$$\text{Total PUE} = \frac{\text{Metering}}{\text{Metering}}$$

- Energy and environmental efficiency
- Instantaneous PUE
- Influencing factors
- Comparison of energy types with the site's meter readings
- Reference

- **Protocol for measuring PUE site by site:**
  - Can be used to track changes on the site (performance, workload, etc.)
  - If PUE is contractualized, sets up sequences of fixed, ongoing and certified measurements
  - Measures in kVA and kW
- **Protocol for measuring PUE room by room can be used to:**
  - Show that the room's demand is not tied to variations in the outdoor temperature
  - Quantify the gains from implementing a solution or a modification in a room
  - Isolate the performance of a specific customer

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