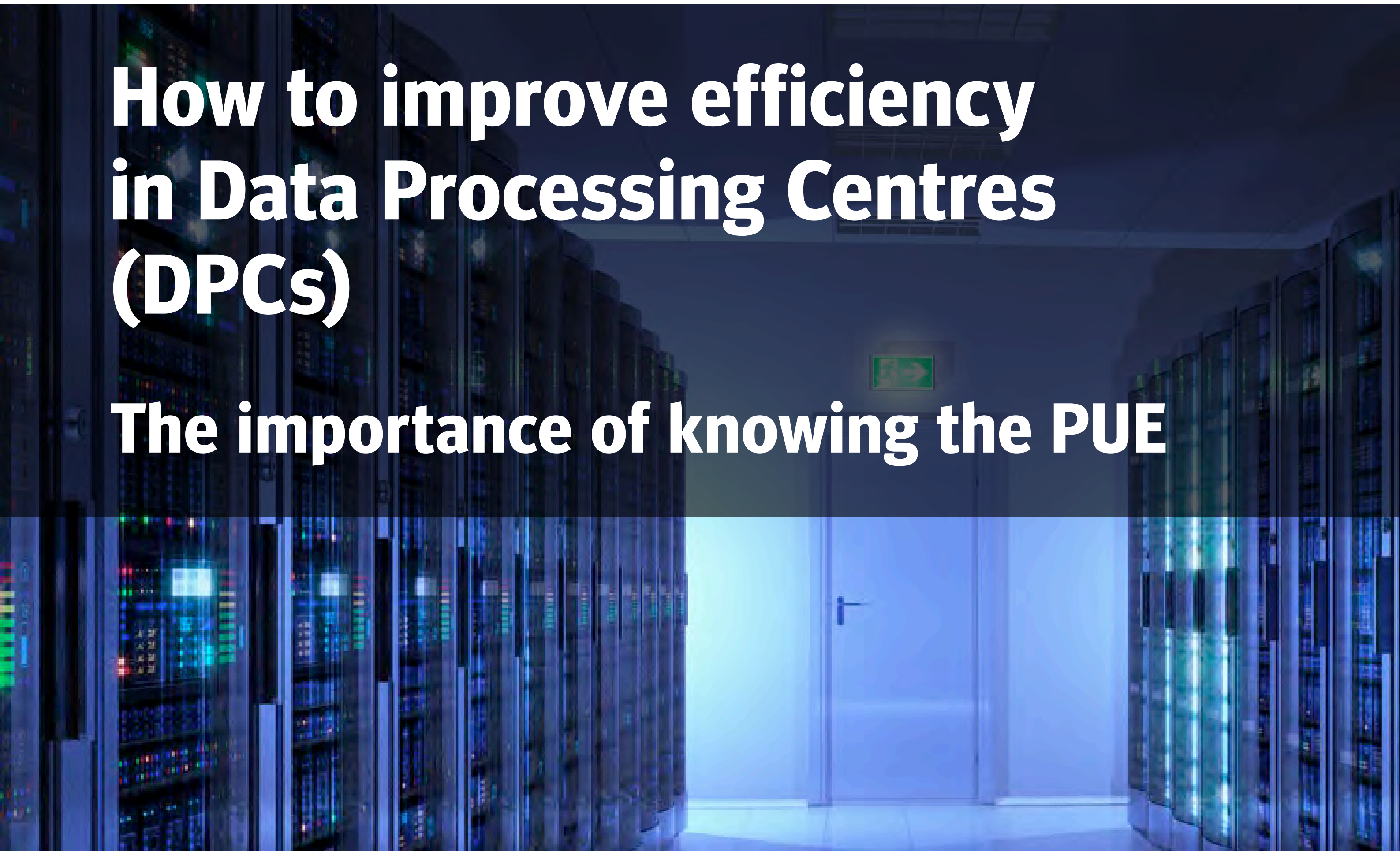
Technical article

Francisco Domínguez
Network Quality Division



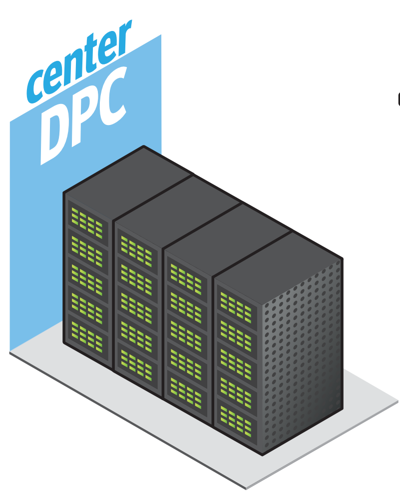
How to improve efficiency in Data Processing Centres (DPCs)

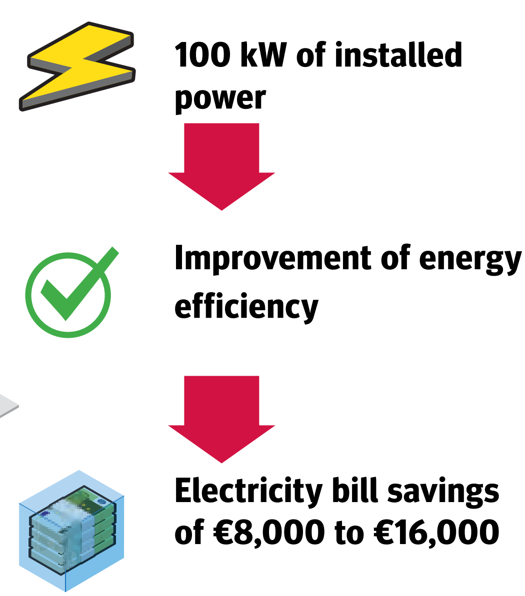
The importance of knowing the PUE

Managing effective energy use

▶ We can calculate the energy efficiency of any production system by comparing the useful energy with the total energy needed by the system. With this information and knowing where the inefficiencies are, we can achieve substantial savings and more environmentally-friendly operations.

As a practical example, an average data processing centre with installed power of 100 kW can achieve savings of €8,000 to -€16,000 in the electricity bill as a result of improved energy efficiency. To do so, it is as important to detect the points of consumption as it is to assess the corrective measures.
The energy factor is so critical in data processing centres that it has its own indicator: **PUE** or **Power Usage**





Practice example in a data processing centre, thanks to energy efficiency improvements

The European Commission also has a code of conduct for reducing the impact of data centres' growing energy consumption.

Effectiveness, defined by a standard issued by **The Green Grid**, a global environmental agency comprised of over 175 internationally renowned companies.

The European Commission also has a code of conduct for reducing the impact of data centres' growing energy consumption. It periodically publishes best practices for data processing centres, most recently in 2013.

These centres have a peculiar profile due to their uninterrupted working hours. Because of the great importance of service continuity when powering servers, computers and communications, they have three main groups of units for their exclusive use:

- **Energy supply and control units** (electricity and other sources, such as diesel oil, gas, etc.) essential for the functioning of these continuous operation units. This group includes supply connections and switchboards, lighting and refrigeration systems, air conditioning of the corresponding rooms, etc.
- **One or several units to supply power** computer equipment (IT), comprised of UPS (Uninterruptible Power Supply) units
- The **distribution panels and systems** for this energy to power the computer equipment

Broadly speaking, we can say that of the 100% total energy consumed in a DPC, 60% corresponds to the infrastructure's electrical consumption and the remaining 40% to refrigeration systems.
So we can undoubtedly see the need for coefficients (PUE) that make it possible to prepare comparative studies aimed at determining actions for optimising the energy consumption of these centres.

PUE or **Power Usage Effectiveness**, defined by a standard issued by **The Green Grid**, a global environmental agency comprised of over 175 internationally renowned companies.

Calculation guidelines

As we have already seen, we normally use the standard issued by The Green Grid to calculate the **parameters** for **DPC efficiency**. We will distinguish two key indicators:

1. PUE: Power Usage Effectiveness, calculated with the formula:

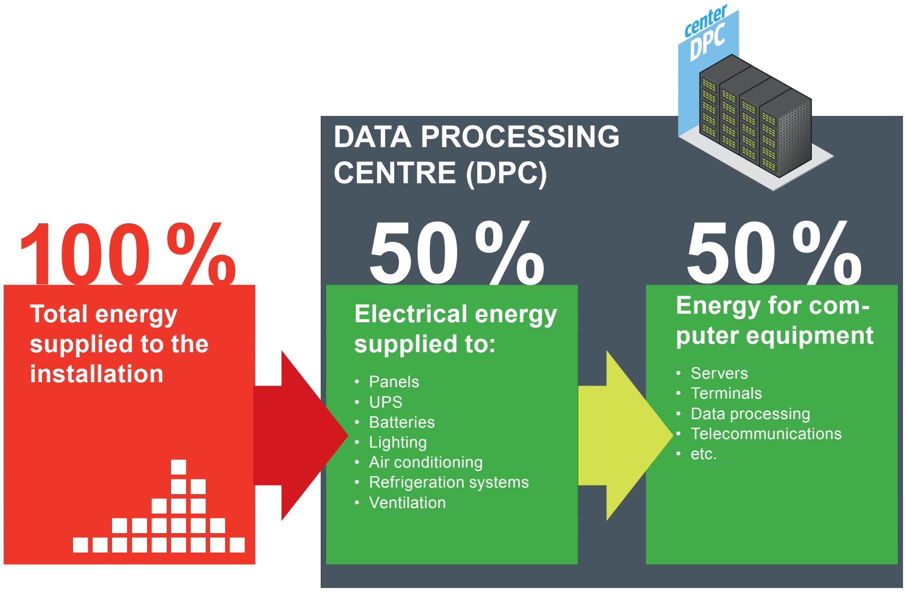
$$\text{PUE} = \frac{\text{Total energy supplied}}{\text{Energy for computer equipment}}$$

2. DCE: Data Centre Efficiency, calculated as a percentage with the formula:

$$\text{DCE} = \frac{\text{Energy for computer equipment}}{\text{Total energy supplied}} \text{ as a \%}$$

In addition, the Environmental Protection Agency of the United States (EPA) provides the following **PUE values as a reference:**

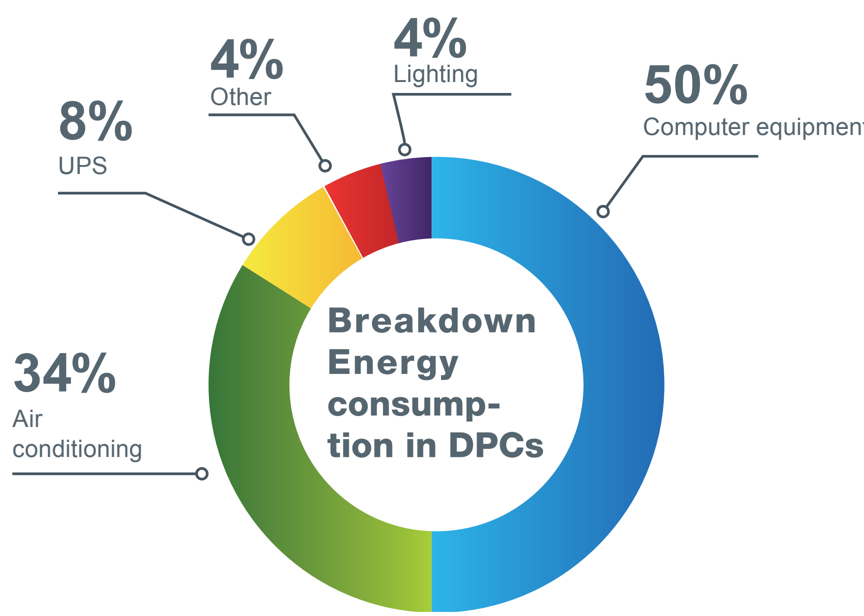
- Historic 2.0
- Current trend 1.9
- Optimised operations 1.7
- Best practices 1.3
- State-of-the-art 1.2



Consumption data INITIAL

Companies like *Google* have gotten the average PUE of their DPCs down to 1.22, and sometimes as low as 1.15.

In the historic frame of reference (PUE 2.0), typical consumption for different DPC elements is:



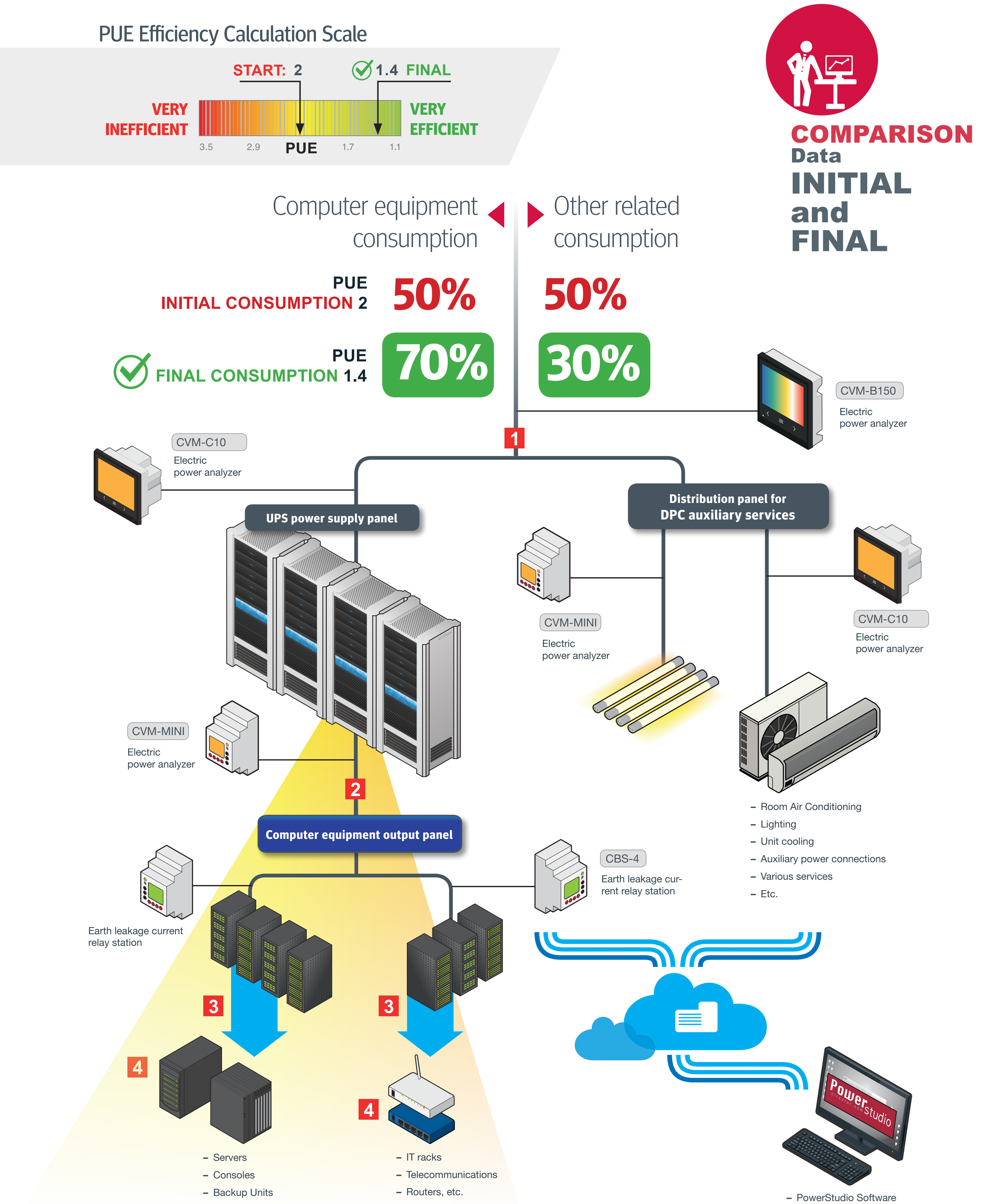
There are **three general measurement levels*** shown in the table below, with measuring points that correspond to the indicators in the diagram also shown below, with energy measured in kWh. A 12-month cycle is taken as a comparative reference for all levels.

There is also a **Level 0**, which only includes **power measurements** (kW), measuring the general demand of the installation and that of the UPS output.

Therefore, one of the keys to the success of an energy improvement project is measuring the consumption of each unit type in order to be able to recognise the most affordable areas of improvement.

	BASIC Level 1 (L1)	INTERMEDIATE Level 2 (L2)	ADVANCED Level 3 (L3)
Total Energy of the Installation	**Installation Inputs** 1	**Installation Inputs** 1	**Installation Inputs** 1
Energy for computer equipment	For UPS output 2	For computer equipment distribution outputs 3	For Computer equipment power supply 4
Measurement Frequency	Monthly / Weekly	Daily / Hourly	Continuous (15 minutes or less)

*The Green Grid recommendations.


PUE Efficiency Calculation Scale
START: 2
1.4 FINAL
VERY INEFFICIENT
VERY EFFICIENT
3.5
2.9
PUE
1.7
1.1
COMPARISON
Data
INITIAL
and
FINAL
Computer equipment consumption
Other related consumption
PUE
INITIAL CONSUMPTION 2
50%
50%
PUE
FINAL CONSUMPTION 1.4
70%
30%
CVM-B150
Electric power analyzer
1
CVM-C10
Electric power analyzer
UPS power supply panel
Distribution panel for DPC auxiliary services
CVM-MINI
Electric power analyzer
CVM-C10
Electric power analyzer
CVM-MINI
Electric power analyzer
2
Computer equipment output panel
– Room Air Conditioning
– Lighting
– Unit cooling
– Auxiliary power connections
– Various services
– Etc.
CBS-4
Earth leakage current relay station
Earth leakage current relay station
3
3
4
4
– Servers
– Consoles
– Backup Units
– IT racks
– Telecommunications
– Routers, etc.
– PowerStudio Software

CIRCUTOR with its decades of experience in **energy efficiency** , solutions, offers a wide range of products that facilitate continuous data gathering for controlling PUE and DCE, UPS unit performance, electric energy management and DPC maintenance. These include **energy meters, power analyzers, ultra-immunised earth leakage protection**, **harmonic filtering** systems, **PowerStudio Scada** management software and **power factor correction** systems.

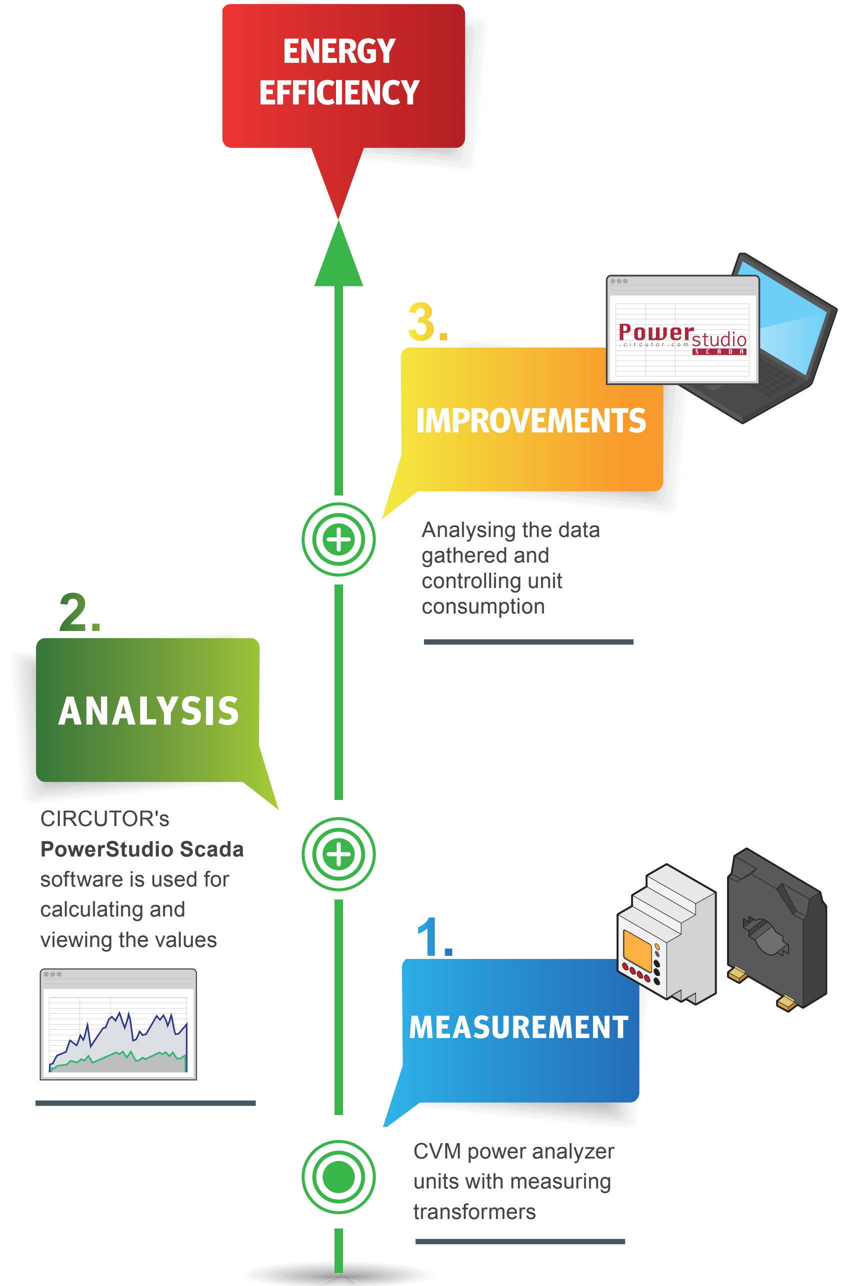
CIRCUTOR's Solution with the SCADA system

For the study, two implementation phases and a third study phase are required:

1-**Measurement**: with the addition of CVM power analyzer units, with their corresponding current transformers, equipped with RS485 serial communications to measure circulating energy.

2-**Analysis**: installing the PowerStudio Scada application, calculating and viewing the resulting values and running the corresponding reports.

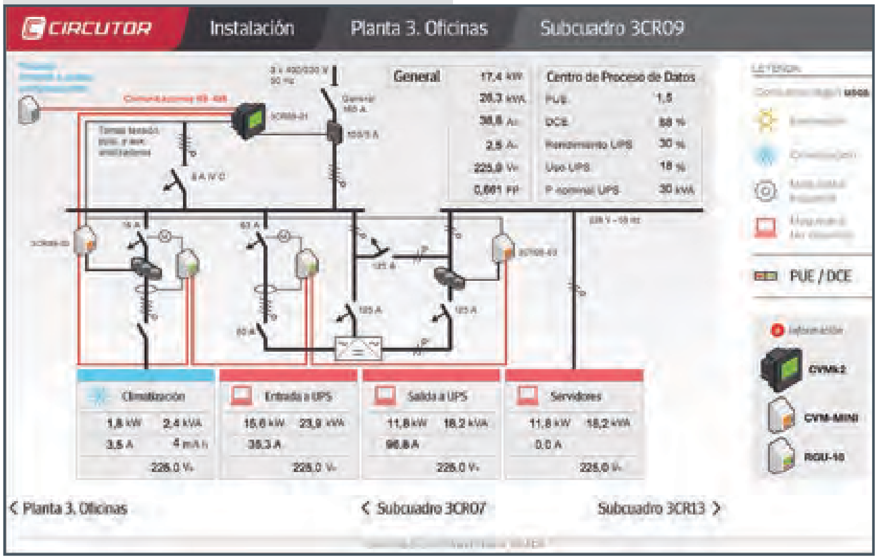
3-**Improvements**: analysing the collected data lets us see which units are consuming.



These are some of the products offered by CIRCUTOR to facilitate continuous data gathering for controlling PUE and DCE, UPS unit performance, electric energy management and DPC maintenance, in addition to many other applications

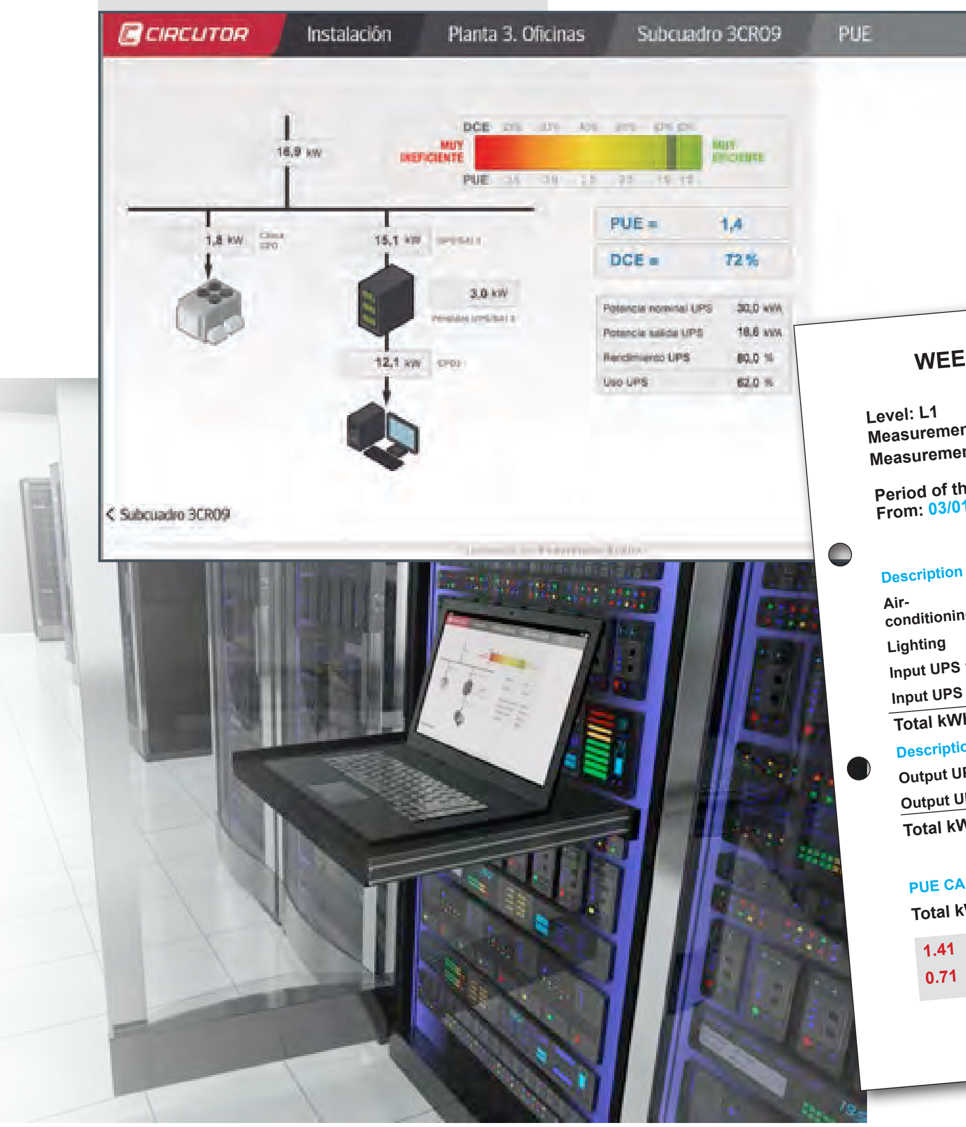
PowerStudio SCADA application

Fig. 1



PUE calculation screen

Fig .2



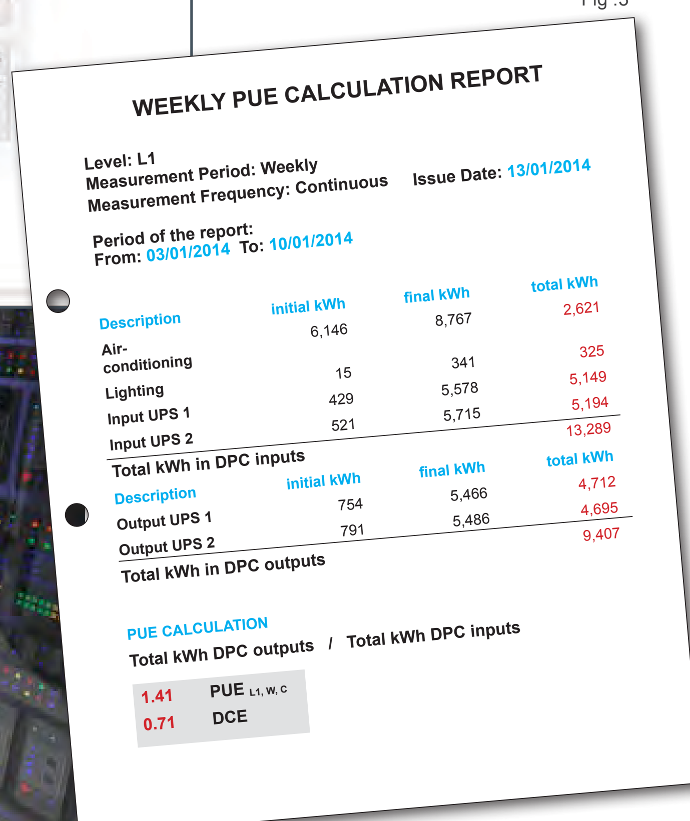
The application features:

- A start screen in single-line diagram format (Fig.1) with data corresponding to all the concurrent energy types (converted to KWh).
- A second summary screen (Fig.2) with performance calculations (Fig.3), enabling you to create and display reports with results for different periods (daily, weekly, monthly and yearly).

By way of example, here are the screens displayed when installing CVM analyzers and programming a specific Scada application.

On the first one you can see the installation diagram and unit connections; on the second one you can see the resulting data online for a single DPC; and on the third one is a weekly Level 1 report with continuous measuring frequency.

Fig .3



WEEKLY PUE CALCULATION REPORT

Level: L1
Measurement Period: Weekly
Measurement Frequency: Continuous
Issue Date: 13/01/2014

Period of the report:
From: 03/01/2014 To: 10/01/2014

Description	initial kWh	final kWh	total kWh
Air-conditioning	6,146	8,767	2,621
Lighting	15	341	325
Input UPS 1	429	5,578	5,149
Input UPS 2	521	5,715	5,194
Total kWh in DPC inputs			13,289

Description	initial kWh	final kWh	total kWh
Output UPS 1	754	5,466	4,712
Output UPS 2	791	5,486	4,695
Total kWh in DPC outputs			9,407

PUE CALCULATION
Total kWh DPC outputs / Total kWh DPC inputs

1.41	PUE L1, W, C
0.71	DCE

*Note: the data on the screens may vary depending on the moment when the data was captured

CIRCUTOR's Solution with a local display screen

For the study, two implementation phases are required:

1-Addition of **CVM power analyzer units** with their corresponding current transformers, equipped with RS485 serial communications to measure circulating energy.

2- Addition of an **EDS energy controller** with storage and data processing functions and its built-in programming, along with a **local display screen**.

By way of example, here is the communication topology displayed when installing CVM analyzers, the EDS energy controller and the local display screen.

How to improve the efficiency of a data processing centre

To improve the efficiency of a data processing centre, we must follow measuring and analysis by implementing **improvement actions**. There are actions that do not require any investment, such as reducing the contracted power to save on direct costs, and other actions that do require investment, such as replacing units with more efficient ones.

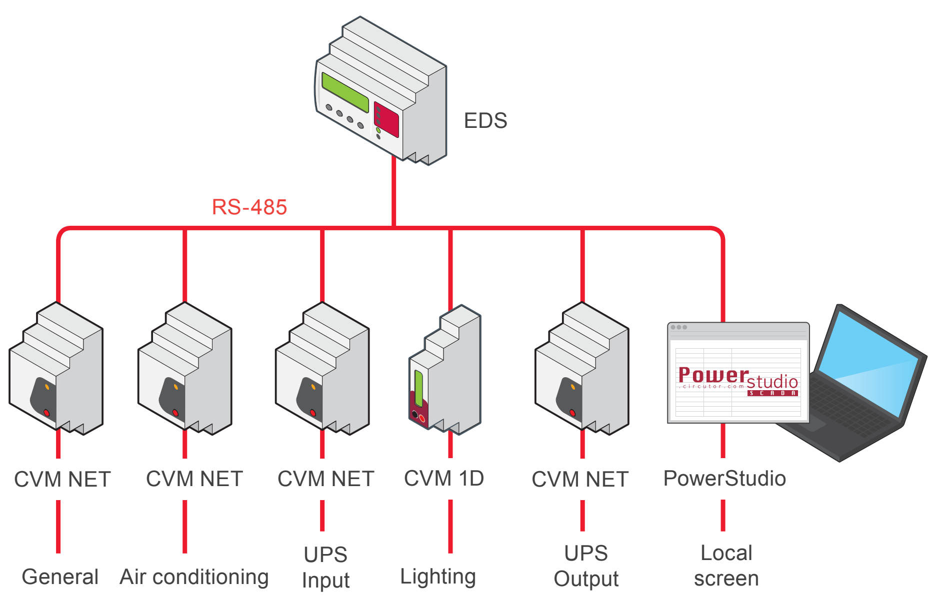
To organise these improvement actions you can prioritise them in accordance with the efficiency that can be achieved with each one. This prioritisation is calculated by comparing the improvement obtained with the investment required to make the improvement.

$$Pa = \frac{CEa - CEm}{Investment}$$

Pa: Action priority
CEa: Current energy consumption
CEm: Energy consumption with the new measure.
Investment: investment needed to achieve the savings

CIRCUTOR EDS

Energy manager with PowerStudio and built-in web server



CIRCUTOR's Solution with a local screen

CIRCUTOR, with its decades of experience in energy efficiency solutions, offers a wide range of products that facilitate continuous data gathering for control, maintenance and energy efficiency management of Data Processing Centres (DPCs)

Performing this calculation for each possible improvement action helps us prepare a list of actions and sort them from highest to lowest priority.

Possible **short-term measures** include:

- Analysing **usage patterns** for the environments where they have been deployed.
  - Calculating the minimum server group sizes to maintain service levels.
  - Switching off unused capacity, as long as proper availability is maintained.
- **Virtualisation and consolidation**
- Replacing **hardware**
  - Virtualising test environments.
  - Replacing obsolete hardware.
- Changes in **room management**
  - Correct control and adjustment of room temperature.
- Changes to the **refrigeration** infrastructure.
  - New efficient **refrigeration** machinery.
  - Hot aisle/cold aisle layout.
  - Elimination of "gaps" in the racks.
  - Future: use of outside air.
- **Lighting** optimisation

For a more thorough list of Data Centre improvements, see the *"2013 Best Practices issued by the European Commission's Renewable Energies Unit."*

Conclusions

DPCs (Data Processing Centres) are major consumers of electrical energy and their consumption can be divided in useful energy for computer equipment and the additional energy necessary for their smooth functioning. This energy consumption is so critical that it has its own indicator: **PUE** (**Power Usage Effectiveness**).

In DPCs with non-optimised PUEs, this additional energy can account for up to 50% of the total energy, giving us good room for improvement. According to minimum availability requirements and the options for investment in improvements, savings of up to 20% of the total energy consumed can be achieved (or between €8,000-€16,000 a year in an average 100 kW DPC).

As we have seen in this article, it is possible to study and measure possible improvements to data processing centres. The key phases are installing energy measuring units, analysing the data gathered and making decisions based on that analysis.

CIRCUTOR, with its decades of experience in **energy efficiency** solutions, offers a wide range of products that facilitate continuous data gathering for control, maintenance and energy efficiency management of DPCs.

For further information **contact us on CIRCUTOR's website** **www.circutor.com** or **through one of our local sales representatives in your area.**