UPS EFFICIENCY

Saving Europe's Energy

The main function of a UPS is to protect sensitive loads (computers, servers, critical medical equipment, automated processes, etc.) against power disturbances that can affect their operation or service life, often with serious consequences.

Many types of disturbances can affect electrical power during transmission or distribution including:

- Major voltage fluctuations (surges or dips)
- Frequency variations
- Harmonic distortion and transients
- Brief or extended outages

For this reason, UPSs are increasingly installed as power-protection interfaces between the utility power point and sensitive loads.

When choosing a UPS, it is important to take operating costs into account.

These costs are directly related to the electrical efficiency of the UPS under real operating conditions.

This document provides a basic review of efficiency aspects to help users, installers and designers in choosing an energy-efficient UPS.

CEMEP
European Committee
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of Electrical Machines
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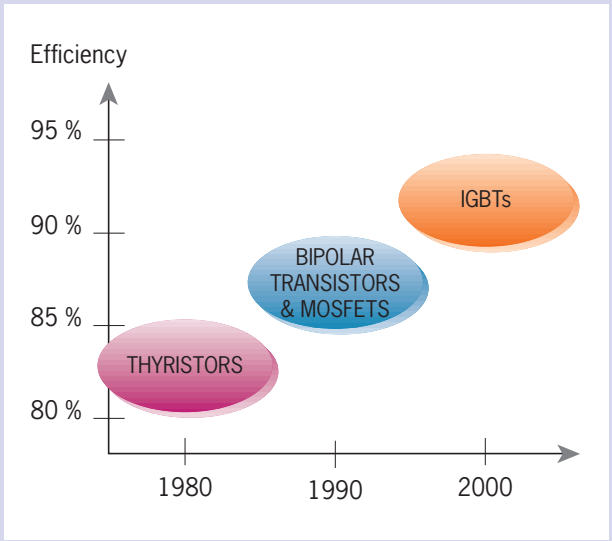
Efficiency: a key characteristic that is improving continuously

The choice of a UPS must take into account a number of technical and economic aspects including:

- the types of disturbances that the load must be protected from.
- the required technical performance (voltage and frequency regulation, reliability, size).
- the required operational efficiency.

For over 25 years, electrical efficiency has been one of the characteristics that manufacturers have strived to improve, in particular by developing new UPS topologies and by using new power components.



A 15% increase in efficiency has reduced losses by a factor of 4 !

Efficiency: the important parameters

To avoid unpleasant surprises (high operating costs, inadequate ventilation or air-conditioning), a number of parameters must be considered when comparing UPS technologies and topologies, each presenting certain advantages but also very different characteristics.

Topologies

The different UPS topologies are defined in annexes B and D of CENELEC standard EN62040-3.

- Passive standby UPSs: the passive standby topology offers very high efficiency given that the load is supplied directly by the utility under normal operating conditions and only transferred to the UPS in the event of a utility outage. However, such UPSs are classified as VFD (see EN62040-3 Annex D), meaning that there is no regulation of input voltage and frequency variations. Such UPSs are generally reserved for applications that are not highly critical and for low power levels (1 to 3 kVA).

- Line interactive UPSs: the line interactive topology also offers high efficiency, but this can depend on input voltage and frequency characteristics.

Such UPSs are classed VI (see EN62040-3 Annex D) and do not provide frequency regulation. They are used in environments not subject to heavy disturbances and for low and medium power levels.

- Double-conversion UPSs: given the continuous operation of the AC/DC and DC/AC converters, the double-conversion topology offers less higher efficiencies when utility power is undisturbed, however the efficiency is virtually independent of input voltage and frequency variations.

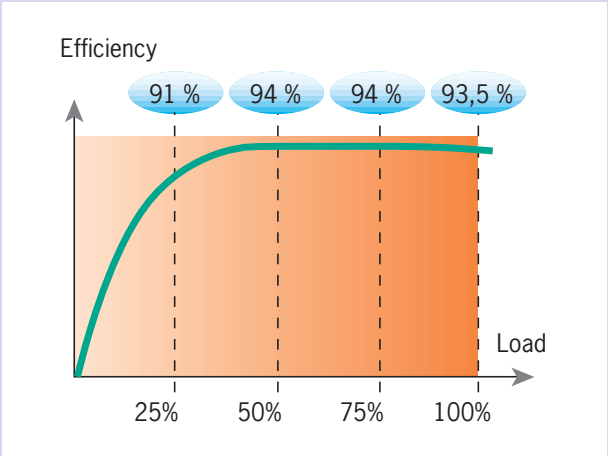
Such UPSs are classified as VFI and have power ratings from 1 to 1000 kVA. They are considered to provide optimum protection of sensitive equipment in disturbed environments.

■ Load level

A UPS is rarely used at full rated load, in particular in installations using redundant UPSs to provide continuous protection even when one of the units fails or is being serviced. The load is therefore generally lower than 100% of the rated capacity.

Given that certain losses are practically constant, the efficiency will decrease with load level. It is therefore important to ask the UPS manufacturer for efficiency curves at typical load levels, often 25 to 50% of the full rated load.

It is also important to avoid oversizing the UPS with normal power not to far from the load level, as at low load the efficiency decreases. An optimum efficiency curve should have the following shape:



■ Type of load

The loads supplied by UPSs may have very different characteristics.
The loads are seldom linear (perfect sinewave) and non-linear loads have a non-sinusoidal current with a high harmonic content.
This is particularly the case for computer hardware and medical and industrial equipment.

It is therefore essential to know the actual efficiency of a UPS when supplying this type of load, as certain converter technologies are very sensitive to non-linear loads.

Different technologies can be compared using the reference non-linear load defined in annex E of standard EN62040-3.

■ Input voltage variations

The efficiency is often given for a nominal utility voltage of 230 or 400 V. Once again, continuous operation at a different voltage level, for instance 210 V or 370 V, can alter the UPS efficiency.
This point should always be checked with the manufacturer.

Measuring UPS efficiency

Efficiencies given in commercial documents are often the values measured at the full rated load (100% FLR) of the UPS, with a linear load and the nominal input voltage and frequency.

UPS efficiency is expressed as the ratio between the active output power and the active input power, without any transfer of energy to or from the battery (i.e. battery fully charged). The measurement must be made with appropriate instruments, in particular for non-linear loads. Standard EN62040-3 (part 6.3) defines the equipment that should be used.

Efficient measurements may be part of Type Tests carried out by the manufacturer for a certain product range or Routine Tests carried out during production.

Depending on the actual conditions of use, these measurements will be carried out for different cases:
- Linear and non-linear loads (standardized)
- Load levels from 25% to 100%
- Different input voltages and frequencies within the indicated tolerances
- Different types of operation

These efficiency measurements can be used to calculate the UPS losses under different operating conditions.

These values are very important and must not be under-estimated as they are often used to size the ventilation and air conditioning of rooms housing medium and high power UPSs.

An under-estimation will increase electrical consumption but could also have catastrophic consequences on the reliability and availability of the power-protection installation.

Choosing the right UPS

Choose the technology best suited to the need, environment, application and required availability :
- VFI : Voltage and Frequency Independent
- VI : Voltage Independent
- VFD : Voltage and Frequency Dependent

Once the type of UPS has been defined, compare the characteristics guaranteed by the manufacturer, possibly based on tests carried out by an independent laboratory under real operating conditions.

To achieve the required performance level, choose the UPS presenting under real operating conditions both the lowest operating cost and highest efficiency.

Today, manufacturers belonging to the European Committee of Manufacturers of Electrical Machines and Power Electronics (CEMEP) are making continuous progress in the protection of the environment through product design, operating energy savings and end-of-life recycling.

CEMEP associates the main UPS manufacturers in Europe through the national associations.

CEMEP is the representative of the manufacturers of UPS towards the European Commission.

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