EuP lot 27 – Uninterruptible Power Supplies (UPS) Task 1, 2 and 3 briefing note

Introduction

With this document the project team would like to start an effective stakeholder dialogue and hereby invite stakeholders to participate actively throughout this Ecodesign Directive preparatory study. An overview of the Ecodesign Directive and the supporting processes and timelines are available at http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/decision-making/index_en.htm…

Experience from previous Ecodesign preparatory studies suggest two benefits from close and early stakeholder collaboration. Firstly, the quality of the study's results increase substantially with a regular input of information and data from the stakeholders. Secondly, the stakeholders themselves benefit from timely status updates and the option for direct feedback for their individual questions.

This briefing outlines some relevant aspects in conjunction with the study's first three tasks ahead of the first stakeholder workshop. This includes the product group definition of UPS, related product scope for study and market analysis as well as technical questions. It should be noted that this is only briefing note and that the draft Task 1 to 3 Report will be completed only once the team has concluded the workshop.

This briefing highlights specific points for which we value your input, feedback and data. We would greatly appreciate your active contributions. The study is particularly in need of current market data and forecasts, information on new technologies and best available technologies in terms of high energy efficiency solutions. Please contact us directly for discussions. We welcome data, information, and comments in written form to ecoups@aeat.co.uk

Throughout this document we have emphasised points for your expert consideration.

Disclaimer

The findings presented in this document are results of the research conducted by the AEA consortium and are not to be perceived as the opinion of the European Commission.

Uninterruptible Power Supplies – previous relevant work and this project

UPS were identified as a priority product group under the Eco-Design working plan 2009-2011[1]. This preparatory study is the starting point of this process. It aims to identify what are the current market size and composition, technical solutions, potential future technology improvements and possible policy options.

UPS manufacturers have greatly improved the efficiency of their products in recent years, and have been heavily involved in developing a European Code of Conduct and the US Energy Star rating. The work undertaken by this study requires that these initiatives (all voluntary) are reviewed and that their remit if appropriate is taken into consideration within the technical assessment that will be undertaken:

- UPS Code of Conduct had been in place since 2008. It is headed by the EU JRC and a number of larger manufacturers have signed up to it.
- UPS US Energy star took effect on 1st of August 2012, and should take effect in Europe following the European Union Energy Star Bureau (EUESB) consultation and once it has been through the EU process. As of September 2012 there has been no published timetable for this to be completed.
- Standardisation works, both at the European (Cenelec TC 22X) and at the international level (SC 22H) and the new standard, IEC 62040-4 which is still under development which will address Energy Efficiency, GHG, substances and directives on substances and recycling (WEEE and RoHS).
- CEMEP has produced on a regular basis documents and tools to help the UPS market stakeholders to seize opportunities to acquire highly efficient products.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0660:FIN:en:PDF

Tasks 1 product group definition

Proposed definition

For manageability and focus, we propose that the study primarily considers, but is not restricted to AC powered static and semi portable UPS utilising various battery technologies from lead-acid to Li-Ion.

Initial research carried out on definitions from a range of sources (including category definitions for UPS in ProdCom, EN, IEC and ISO standards, International labelling and product compliance systems, Energy Star, EU trade associations and DigitalEurope) indicate a range of definitions. The following definition is the one we are proposing for the product group. Initial questionnaire findings indicate stakeholder agreement for the definition proposed.

Product group definition:

"A UPS is a combination of electronic power converters, switches and energy storage devices (such as batteries) constituting a power system for maintaining the continuity of power to a load in the case of input power failure."

Qualifying Notes:

Input power failure is usually understood to mean the failure of the main primary continuous power source (e.g. the AC grid). It can also mean the failure of the primary power source to maintain voltage and frequency within rated steady state and transient bands or to allow distortion or interruptions to the supplied power outside specified limits.

A UPS is commonly understood to be a short duration (minutes/hours) power supply system that maintains the functions of the connected load when the main continuous power source has failed. The primary purpose of a UPS is to bridge an unexpected power gap and/or to provide the amount of power needed to safely power down the connected load. A UPS may also be used to continuously maintain the quality (distortion content) and stability (voltage and frequency) of the power to the connected load.

In the case of a primary AC grid failure, the UPS may run in isolated mode and is not grid-connected on the supply side.

In standby (when it is not replacing primary grid power) a UPS could operate in on-mode or off-mode, as an AC or DC operated device depending on the specific design.

A system providing electrical power, that supplements or is capable of continuously replacing the main source of grid power, is not a UPS (e.g. an engine or generator system).

This definition was put forward in the questionnaire no1 and respondents that have returned completed questionnaire agreed with it.

Stakeholders' input:

At this stage of the preparatory study process we would like to agree a product group definition and welcome comments on the above proposal.

The team would like to discuss with stakeholders how the study should deal with the following technologies:

- Other standby energy systems categorised as UPS
- Fuel cell based UPS (mobile communication)
- Engine/motor driven UPS (hospitals and mobile communication)
- Grid connected or isolated battery storage UPS systems deriving electrical energy from solar PV and wind generation
- Gas turbine driven UPS
- Flywheel/motor driven modules
- Hydro power pump storage
- Compressed air storage
- Non-grid connected UPS (solar house systems).

We intend to focus on the most ubiquitous UPS systems, i.e. those that operate with no time delay, as this equipment is responsible for the highest market share and deployed stock.

We welcome views on the above.

Test and Standards

As part of the work we are identifying and reviewing existing standards and test method and ones under developments. This is to help inform the product group definition and to provide an account of appropriate standards for testing. Relevant standards identified to date are:

- US Energy Star Program Requirements for UPS and Test Method Final May 2012 (all UPS)
- EU Code of Conduct on Energy Efficiency and Quality of AC UPS. Edition 2.0 May 2011.04.2010 Energy Efficiency for Telecommunication equipment. Methodology for measurement and reporting of DC power plant The UK energy technology list UPS criteria http://etl.decc.gov.uk/NR/rdonlyres/46E23001-0475-4AF6-B57B-B03938BA04F6/0/12_UPS.pdf
- EN62040-3 UPS Method of Specifying the performance and test requirements
- EN62040-1-1 and 1-2 UPS General and safety requirements
- EN62040-2 UPS Electro-Magnetic (EMC) compatibility requirements
- EN61000-4-1,-4-2,-4-3,-4-4,-4-5,-4-6,-4-11,-6-4,-2-2, Various EMC testing and measurement techniques and standards.
- ATIS-0600015 .04.2010: Energy efficiency for telecommunication equipment. Methodology for measurement and reporting of DC power plant.
- ATIS.0600015.2009: Energy efficiency for telecommunication equipment. Methodology for measurement and reporting. General requirements.
- EN60896 Stationary lead-acid bartteriesEN50272-2: Safety requirements for secondary batteries and battery installations, stationary batteries.

Stakeholder's inputs

There are many other EN and IEC standards relating to UPS installation and associated infrastructure, we welcome the identification of any of these that are deemed important in qualifying UPS installation costs and running costs.

Task 2 – Economic and market analysis

The only data provided so far has been from CEMEP the European association of UPS manufacturers.

Generic Economic Data

In term of European production of UPS, CEMEP estimated that:

- Almost all single-phase UPS are manufactured outside of the EU27.
- 20% of 3-phase UPS units are manufactured within the EU27, and that 80% of units are manufactured outside of the EU27.

The current and projected value of UPS markets across the EU27 for 2010 and the next 5 years are shown in Figure 1.

The data shows that the market was worth about €1118M in 2010, but in 2011 and 2012 the market stagnated. CEMEP is forecasting that the market will recover in 2013 and that the overall EU27 market value will grow by 4% compared to 2010 to a total of €1164M.

It was estimated by CEMEP that **single-phase UPS** market is split as followed:

By revenue:

- Stand-by UPS (VFD)[2] represent 12% of the market value
- Line Interactive UPS (VI)[3] represent 48% of the market value, and
- On-line UPS (VFI)[4] a further 40%.

In term of units sold, the market is split as follow:

- Stand-by UPS (VFD) – 1.3 million units
- Line Interactive UPS (VI) - 0.64 million units

[2] VDF: variable frequency drive
[3] VI: voltage interactive
[4] VFI: voltage and frequency independent

- On-line UPS (VFI) - 0.2 million units

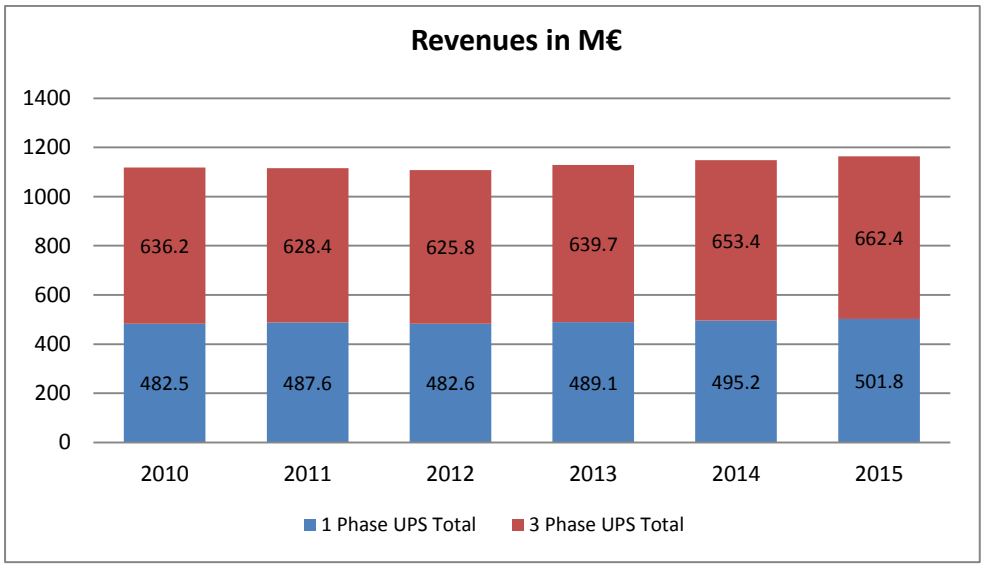

Figure 1: UPS market across Europe

The member states with the largest estimated market value (in €) in 2011 were:

Single-phase UPS:

- Germany - €95.7M
- UK - €72M
- Italy - €67M
- France - €63.2M

3-phase UPS:

- Germany – €122.7M
- UK – €116.7M
- France - €100.1M, and
- Italy - €66.1M

Market trends

The UPS market in Western European countries has been growing significantly. Industry spokesmen report strong but competitive business:

- 50% of the sales related to replacements market
- 50% of sales are for new installations
- Market trends towards smaller devices are visible.
- In areas with less reliable national grids, UPS systems are more common than elsewhere.
- It is observed that the market supplying mature technology products is consolidating. Multinational UPS manufacturers belonging to the French Schneider Electric Group and the American Emerson and Eaton have already absorbed several companies.
- The service and maintenance sub sector within UPS is fast growing (driven by the fact that up till recently UPS systems maintenance has been below standard).
- The growth of renewable power with many localised small power plants (PV and wind) will increase the demand of UPS systems as well as the growing concerns over data storage and security and the increased risk of failure affecting electronic devices and systems.
- Providing stable conditions for the IT equipment in use is important so the demand for new UPS installation will increase.
- The replacement rate will remain high due to the short product life cycle of typically three years.

Questions to stakeholders:

Do you agree with the figures presented above?

Can anyone provide similar breakdown market data for 3 phase UPS, as presented for single phase UPS above (as per bottom of page 3)?

What is in your opinion the average lifetime of UPSs? In this context are existing remote monitoring systems for UPS internal batteries adequate and how could they be improved to extend the lifetime of UPS through the avoidance of damage from leaking or distorted batteries.

Task 3 – User behaviour and end of life

The aim of this task is to better understand how users actually implement and utilise UPS and how this has an effect on energy usage.

Real life efficiency

The usage patterns of UPS units / systems are a function of the power quality of the local grid and safety concerns related to the connected equipment. In some cases such as most office PCs, the risk of failure is relatively low and simple UPS units are common. UPS systems in server farms, for air traffic, railway, healthcare and similar purposes need 100% availability and use redundant UPS units to provide emergency backup. UPS configuration appears to some degree to be 'led' by a company's approach to risk management as to how they configure one or more back-up UPS systems or technologies.

UPS operation costs are always a very important issue to the user, in terms of lifecycle costs. Therefore, the user must be informed about the power consumption and losses of the UPSs in the market. The load type and load level have a strong influence on the achieved efficiency and such data should be provided to users. To encourage the high-efficiency design of UPS and support the consumer decisions concerning UPS acquisition, labelling schemes would be helpful. The Energy Star program will label the UPS with a minimum level of efficiency. However, more detailed labelling schemes have been proposed by Swiss Federal Office of Energy and by the Lawrence Berkeley National Laboratory (LBNL).

Stakeholders' input:

Do you think that higher energy efficiency could lead to better safety and reliability (e.g. lower operating temperature, longer autonomy)?

Do you agree with the energy-efficiency labelling of UPS?

If you agree with the previous question, which parameters would you like to see on the label?

Do you know any other labelling scheme (besides Energy Star, Swiss, or and LBNL) implemented or studied?

Repair and maintenance

- Options for repair and maintenance are differing in the various market segments:
  - Mass-market UPS: units for single PCs could see almost no maintenance, and repair options of mass-market units are limited. Some manufacturers of branded mass-market products offer programmes as described below.
  - Commercial UPS Programme: Manufacturers take back old UPSs (regardless of brand) including free return shipping of old battery backup units and will sell a new unit that can be up to 4X the power of the returned unit at a discount price and a standard 2 year warranty.
- Replacement Battery Cartridges - After 3 years, an old UPS may need a replacement battery. Recycling of batteries is provided by some manufacturers free of charge.
- Take Back / Recycling Programmes - According to the WEEE Directive, customers that buy new UPS can return the replaced old equipment for recycling.
- Maintenance frequency - Frequency of maintenance procedures depends on the type of UPS. For small UPS devices inspection should be done once a year. For medium and large systems, inspection and maintenance schedule should include two inspections per year.

Product lifetime

Current findings:

- Transformers: Lifetime of magnetic components is about 40 years.
- Electrolytic DC capacitors: Life of DC capacitors varies from 8 to 30 years.
- Oil-filled AC capacitors: Oil-filled capacitors life is about of 10 years.
- There are lead acid batteries with a nominal life of 3, 5 or 10 years.
- UPS system life expectation if properly maintained is between 10 to 16 years.

Best Practice

Batteries are the main consumable component of a UPS. Most batteries will require removal and recycling within a three-to-four year period, depending on usage and environmental conditions. The current best practices in handling batteries are:

- Lead - Recycling of lead-acid batteries, which are found in the many UPS systems, is well established. About 70 % of the weight of lead-acid batteries is lead. More than 97% of all battery lead is recycled and lead acid batteries are handled in a closed-loop life cycle. Recycled lead is an excellent source for battery manufacturers.
- Lithium - At the moment recycling of lithium batteries is limited to only 3 plants in the EU. While some components are recycled, lithium is disposed of.
- **Plastic -** The plastic used for lead acid batteries is polypropylene and is collected for recycling. The recycled materials are used in manufacturing battery cases
- **Sulphuric Acid –**could be processed and converted to sodium sulphate, used in glass and textile manufacturing. Sulphuric acid is neutralised. After such treatment it could be disposed to waste water treatment.
- **Electronics and Printed Circuit Boards -** Recycling of electronic components in UPS is similar to other PCB based electronics. UPS electronics could contain lead soldering since there was a RoHS exemption for these devices.

Stakeholders' input:

What are the advantages and disadvantages of the existing battery technologies?

What are the current and future trends in lithium battery recycling procedures?

What are your views on higher integration and smaller devices vs. high weight and recyclability?

Local Infrastructure

This section will aim to identify the barriers and opportunities for ecodesign relating to local infrastructure. The MEEuP methodology identifies the following areas for consideration:

- Energy;
- Water;
- Telecom;
- Installers; and
- Physical environment.

Clearly, some of these will be more important for Uninterrupted Power Supplies (UPS) than others, and they are discussed as appropriate below. The impact of any design improvements may only be fully realised if infrastructure elements are taken into consideration, as these in practice may limit the extent of any potential benefits.

Energy:

- A reduction in the energy consumption of the UPS itself will potentially reduce supply side infrastructure losses i.e. less supply is required, therefore the losses associated with that supply will be reduced.
- The variation in the energy supply i.e. level of disturbances required to protect against needs to be understood in order to ensure the correct type of UPS is chosen.
- Correct sizing of the UPS in relation to the local infrastructure it is designed to protect is critical to ensure optimal energy performance i.e. load analysis. It is likely that an extra power allowance will be included to take into account future expansion, typically 30%[5]
- For medium and large UPS, cooling is often necessary to prevent overheating, as higher operating temperatures reduce battery life. This may result in additional electrical energy use for air conditioning. The amount of ventilation may affect the level of cooling required.
- Local infrastructure, such as raised floors and existing air handling ductwork will affect system performance and uniformity of temperatures in facilities, for example data centres[6].

[5] CEMEP UPS Guide
[6] Cooling requirement report

Telecom:

Telecom infrastructure may be an important consideration for UPS installation. It will be important to understand the telecom set up at the local level to ensure the UPS is compatible and installed correctly to ensure communication between the UPS and the rest of the system is optimised where appropriate.

Installers:

A number of UPS suppliers offer installation and start up services to ensure correct and optimal installation. Typically this could include the following[7], depending on the level of service offered/purchased and where the UPS is to be installed e.g. data centre, or small scale:

- Compatibility checks to ensure the UPS is appropriate for the system it will be connected to;
- Review of mechanical and electrical installation requirements;
- Verify floor layout design to ensure efficiency;
- Equipment unloading;
- Upstream mains connection;
- Distribution switchboard connection;
- Battery connection;
- Air conditioning/ventilation

Physical Environment:

The physical environment for UPS has already been touched on in the energy section above in relation to heat load and cooling requirements/ventilation. Linked to this the ambient temperature, which is also important. This can affect the lifetime of the batteries used, depending on their type, for example lead acid battery design life reduces by half for every 10 degrees above the design reference temperature of 20/25°C[8] . It is therefore important, for UPS to be installed in temperature controlled environments if optimum service life is to be achieved.

Although ventilation is considered above as part of heat dispersal, it also needs to be considered to ensure that any potential explosive mixtures of hydrogen and oxygen from batteries are dispersed. Standards, for example EN 50272-2 'Prescriptions for safety of batteries and installations' are available to address such matters.

A further consideration of the physical location of UPS is noise. It needs to be located so as not to impact on noise levels for areas that staff are working in, for example offices.

Stakeholders' inputs:

We welcome any input regarding infrastructure and how UPS needs to be integrated that needs to be taken into consideration by the study.

[7] CEMEP UPS guide and Schneider Electric 'Critical Power and Cooling' brochure
[8] CEMEP UPS Guide