Energy efficiency of power supplies (PS) in ICT-equipment

Bernard Aebischer
Centre for Energy Policy and Economics (CEPE)
Swiss Federal Institute of Technology Zürich (ETHZ)
and
Alois Huser,
Encontrol GmbH, Niederrohrdorf

Overview

1. 1990s
2. Today
3. This study: objectives and approaches
4. Results Lab
5. Results PC in different modes
6. More insights
7. Technical measures
8. Recommendations

1990s

1. Using switched power supplies improves efficiency from (30-50)% to (60-90)%
2. Heavy power distortion by PS of ICT-equipment
3. Low distortion paid by lower efficiency
4. Efficiency and power factor are strongly dependent on the workload

Today

- PS in ICT-equipment are of the “switched” type
- Power factor corrected in most of the equipment
- Nominal power (nameplate wattage) can not be used for dimensioning the infrastructure
- Detailed study of efficiency in small/external PS (Calwell et al.)
- 1st policy measures for external PS
  - EU (code of conduct; session 2)
  - EnergyStar (session 2)
  - California (draft declaration)

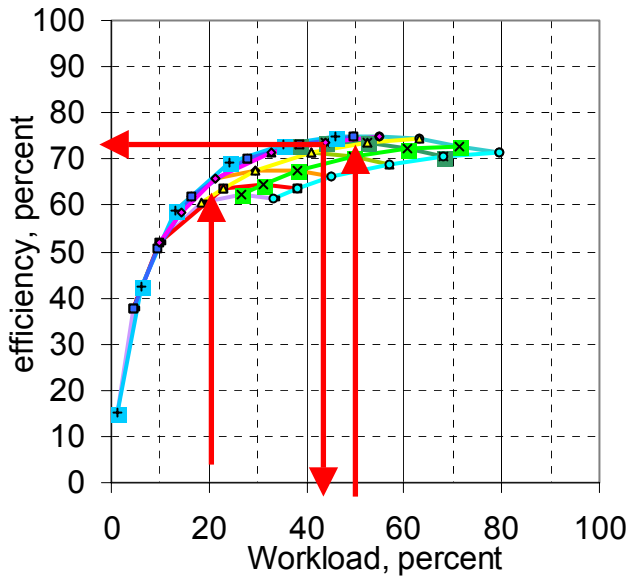
This study

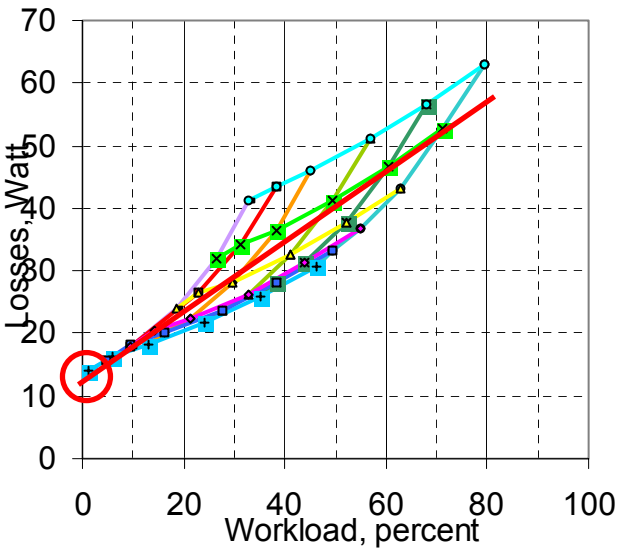
- Objectives
  - Determine efficiency and power factor of PS for ICT in function of workload
  - Determine typical workload of PCs
  - Potentials and measures to foster energy efficiency
- Approaches
  - Measurement of PS in laboratory conditions
  - Measurement of PS-efficiency and workload of PC in use
  - Analysis, synthesis

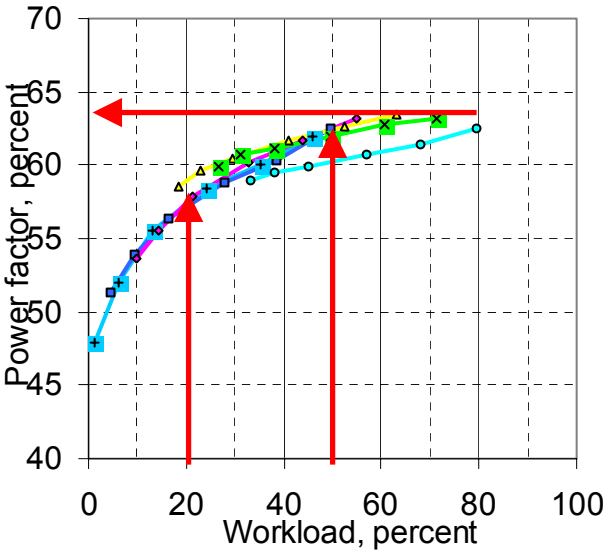
Results (lab-conditions 1)

Summary: Table 1 in paper submitted to EEDAL'03

Example: Minebea 200 W

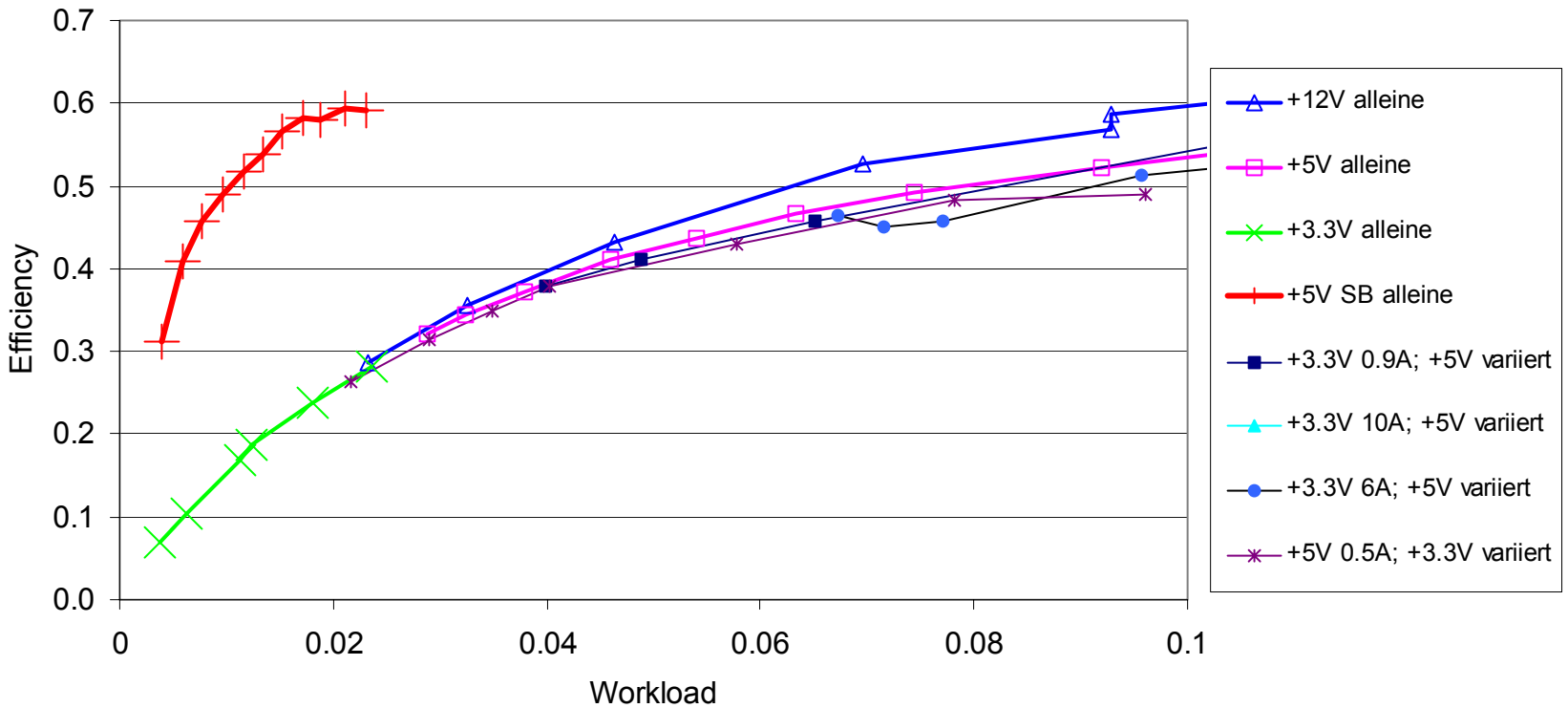






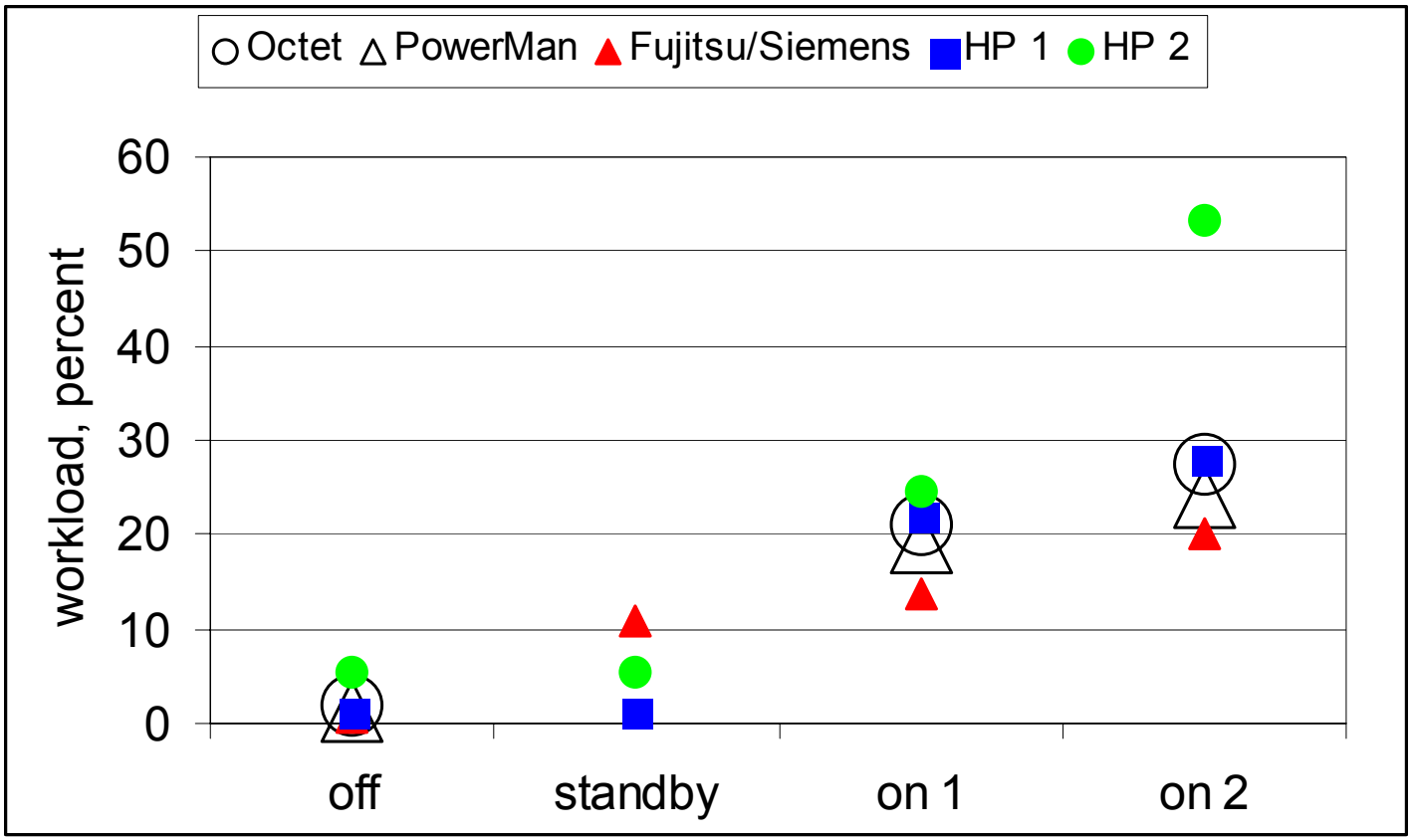
Results (lab-conditions 2)

Example: modern HP power supply, 200 W

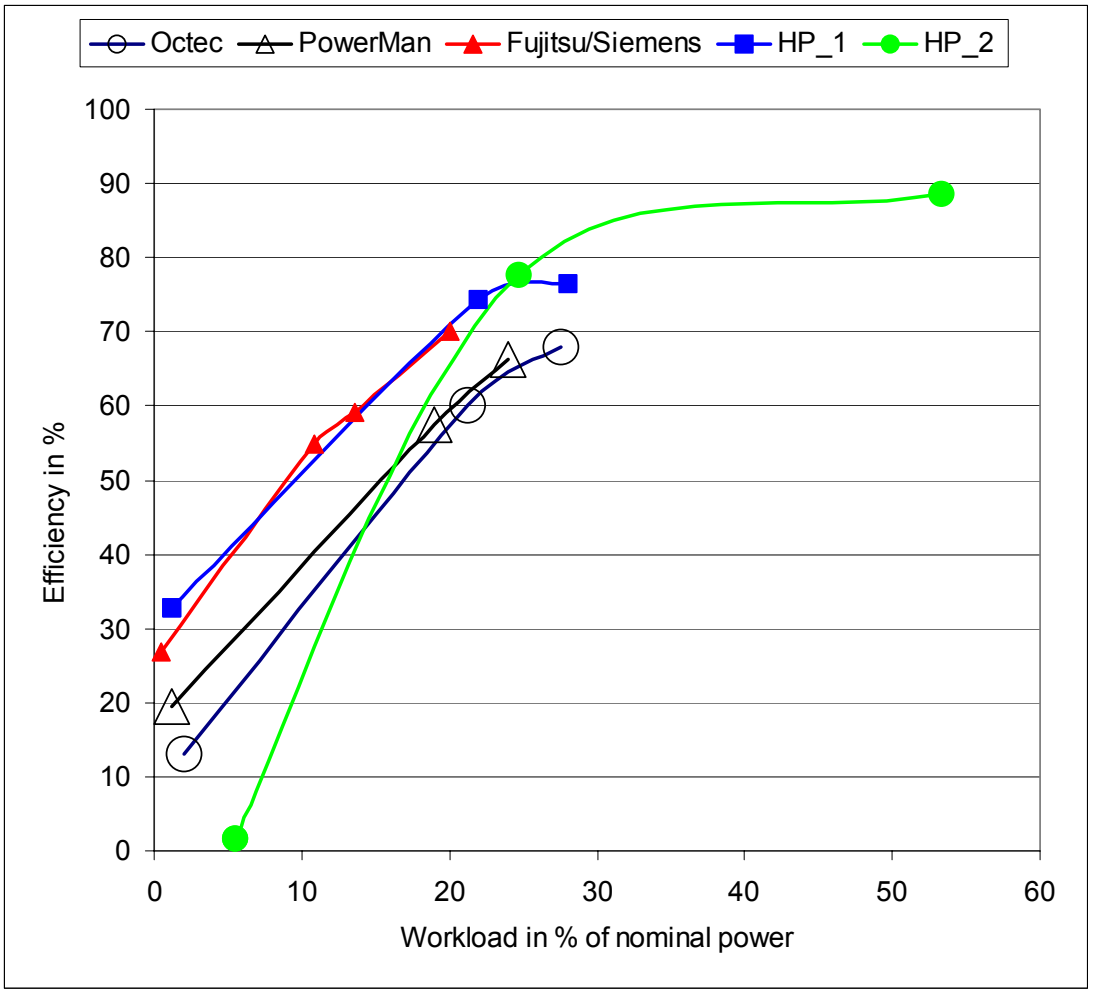


Results (PC in different modes 1)

Modes
- off
- standby
- on 1 (low processor activity)
- on 2 (high processor activity)



Results (PC in different modes 2)



More insights

1. Efficiency depends not only on the workload, but also on the split of outgoing power over the different DC-levels.
2. The DC-output after the power supply unit has to be further transformed (DC/DC) in order to reach the DC-level of the processor (typically 1.5 V today)
3. The overall efficiency (220/110 VAC -> 1.5 VDC) is of the order of 50%

Measures and potential savings

1. Using power supply units with an adequate nominal power in order to reach operating points of 50% or more
2. Using power supply with a separate power supply system from 230 V AC to 1.5 V DC for low power modes of the ICT equipments
3. …. for high capacity load (booster)???
4. With these two measures energy savings of 30% are possible. For PC users the electricity cost savings are of the order of 2 EU/year (for typical private use) and 10 EU/year (for heavy users)

Recommendations

1. Work out an energy declaration for power supply units on an international/global level.
2. Strengthen Energy Labels in two directions:
   - reinforce the requirements regarding power loads in the standby/sleep mode and
   - initiate requirements regarding power loads in the on mode
3. Consider to edict (or to reach a voluntary agreement on) a maximum value for no load losses

Recommendations (Intel)

In "ATX / ATX12V Power Supply Design Guide Version 1.2, Intel Corporation, 2000"

- **General recommendations**: The efficiency of the power supply unit should be at least **68 % under maximum rated load.**
- **Energy Star**: The "Energy Star" efficiency requirements of the power supply depend on the intended system configuration. In the low-power / sleep state (S1 or S3) the system should consume power in accordance with the values listed in Table 8. **Note**: To help meet the "Energy Star" system requirements, it is recommended that the power supply have **> 50% efficiency at light load and in standby mode.**

Definitions (1)

workload is defined as the ratio of power out to nominal or maximal power out