Power Supply Energy Efficiency: Challenges and Opportunities

Chris Calwell
VP, Policy and Research
Ecos Consulting
Presentation to PSMA
March 11, 2002
Key Questions Behind Ecos Consulting’s Power Supply Research

• How many power supplies are out there?
• What does it mean for a power supply to be energy efficient?
• How important are active power efficiency losses compared to standby power consumption?
• Would it be cost effective to improve efficiency?
• What could be done to drive that change?
• How much difference would it make?
## Estimated Power Supply Sales & Number in Use

<table>
<thead>
<tr>
<th>Power Supply Type</th>
<th>North America</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit Sales / Year</td>
<td>Total Units in Use</td>
</tr>
<tr>
<td>External</td>
<td>&gt; 250 million</td>
<td>&gt; 1 billion</td>
</tr>
<tr>
<td>Internal</td>
<td>&gt; 250 million</td>
<td>&gt; 1.5 billion</td>
</tr>
<tr>
<td>Total</td>
<td>&gt; 500 million</td>
<td>&gt; 2.5 billion</td>
</tr>
</tbody>
</table>
## Defining Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>power supply</td>
<td>Circuit cuts AC voltage, converts to DC</td>
</tr>
<tr>
<td>active mode</td>
<td>Full operational state (usually not 100% of rated load, though)</td>
</tr>
<tr>
<td>sleep mode</td>
<td>A lower power state than active mode – product retains some ability to respond quickly to input</td>
</tr>
<tr>
<td>standby mode</td>
<td>Functionally equivalent state to “off” from a user perspective, but may still be drawing some electrical power</td>
</tr>
<tr>
<td>hard “off” mode</td>
<td>Switch allows power to be interrupted in front of power supply, causing zero power consumption in standby mode</td>
</tr>
</tbody>
</table>
What Is an “Efficient” Power Supply?

• “Efficiency” = useful DC power out / AC power in
• Measure both when product is operating (active mode)
• If product has high active power use or long average hours of use/day, active will dominate
• If not, sleep and standby modes may dominate
• Most power supplies always draw less than full rated power (part load efficiency)
• Ideally, a power supply-containing product has minimal standby consumption, high operating efficiency across a wide range of load conditions, and is smart enough to “sleep” after inactivity.
Power Supply Location in the Circuit Matters

1. AC/DC → DC Load
2. AC/DC → DC Load
3. AC/DC → DC Load
4. AC/DC → DC Load

120 VAC
Multiple Places for Efficiency Loss

120 VAC

100% → AC/DC 70% → DC Load

100% → AC/DC 70% → DC Load 1

DC/DC 80% → DC Load 2

100% → AC/DC 50% → Battery Charge

40% → DC Load 40% → Battery Discharge

fans
noise
HVAC
Total U.S. Electricity Flowing Through Power Supplies:
207 billion kwh/year, worth about $17 billion/year
At least 6% of U.S. electricity use!
Savings Potential is Huge

- What if all linear power supplies were improved from about 30% efficiency to 80%?
- What if all switching power supplies were improved from about 70% efficiency to 80%?
- Annual savings would be more than 1% of total U.S. electricity use: about 32 billion kwh and more than $2.5 billion in lower energy bills.
- Very cost effective – incremental costs often less than $1 (in some cases pennies) per power supply.
- Additional savings possible from substantial reductions in standby mode power consumption (currently averages 50 to 100 watts/home in many industrial countries).
## Which Power Supply-Containing Products Use the Most Electricity?

<table>
<thead>
<tr>
<th>Product</th>
<th># in Use</th>
<th>Active kwh/year</th>
<th>Sleep kwh/year</th>
<th>Standby kwh/year</th>
<th>Total kwh/year</th>
<th>Total twh/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog TV</td>
<td>250,000,000</td>
<td>105.1</td>
<td></td>
<td>33.8</td>
<td>139.0</td>
<td>34.7</td>
</tr>
<tr>
<td>Desktop Computer (C/I)</td>
<td>94,000,000</td>
<td>296.1</td>
<td>18</td>
<td>6.6</td>
<td>321.0</td>
<td>30.2</td>
</tr>
<tr>
<td>Computer Monitor (C/I)</td>
<td>94,000,000</td>
<td>205.0</td>
<td>20</td>
<td>2.2</td>
<td>227.7</td>
<td>21.4</td>
</tr>
<tr>
<td>Minicomputers</td>
<td>2,000,000</td>
<td>3,854.4</td>
<td></td>
<td></td>
<td>3,854.4</td>
<td>11.8</td>
</tr>
<tr>
<td>Uninterruptible Power Supply</td>
<td>29,500,000</td>
<td>314.8</td>
<td></td>
<td></td>
<td>314.8</td>
<td>9.3</td>
</tr>
<tr>
<td>VCR</td>
<td>150,000,000</td>
<td>6.0</td>
<td></td>
<td>49.6</td>
<td>55.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Desktop Computer (Res)</td>
<td>75,000,000</td>
<td>79.7</td>
<td>4</td>
<td>16.0</td>
<td>99.7</td>
<td>7.5</td>
</tr>
<tr>
<td>Computer Monitor (Res)</td>
<td>75,000,000</td>
<td>56.9</td>
<td>4</td>
<td>29.1</td>
<td>89.7</td>
<td>6.7</td>
</tr>
<tr>
<td>Mainframe Computer</td>
<td>110,000</td>
<td>38,544.0</td>
<td></td>
<td></td>
<td>38,544.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Stereo Component</td>
<td>75,000,000</td>
<td>73.2</td>
<td></td>
<td>9.2</td>
<td>82.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Cordless Phone</td>
<td>128,400,000</td>
<td>31.3</td>
<td></td>
<td>12.0</td>
<td>43.3</td>
<td>5.6</td>
</tr>
</tbody>
</table>
National Electricity Use and Savings Potential for Various Products Containing Power Supplies

![Graph showing national electricity use and savings potential for various products.]

- Analog TV
- C&I Computer
- Cordless Phone
- UPS
- Security System
- Minicomputer
- C&I Computer Monitor
- Answering Machine
- VCR

The graph plots total electricity use (Twh/year) on the x-axis and savings potential (Twh/year) on the y-axis. Each product is represented by a data point on the graph.
Total Number of Power Supply-Containing Products in Use in the U.S., by Wattage

Active Power Consumption (watts)

- 0 to 4.9
- 5 to 9.9
- 10 to 19.9
- 20 to 49.9
- 50 to 74.9
- 75 to 99.9
- 100 to 10,000

Millions of Products in Use
Total Number of Power Supply-Containing Products in Use in the U.S., by Unit kWh/year
Policy Ideas on the Table

• Consider active, sleep, and standby efficiencies in Energy Star specifications for electronics
• Use federal, state, and private procurement to encourage sale of highly efficient designs
• Targeted financial incentives directed at OEMs, final assemblers, retailers, or consumers (idea proposed by CEC Commissioner Dr. Art Rosenfeld in SF)
• Federal and/or state-level efficiency standards
• Working through voluntary industry specifications like Intel’s PC 2000 process
### Power Supply Market Snapshot

#### Key Market Players

<table>
<thead>
<tr>
<th>Component Manufacturers</th>
<th>Power Supply Manufacturers</th>
<th>Original Equipment Manufacturers (Computers, TVs, Appliances, etc.)</th>
<th>Retailers</th>
<th>Distributors</th>
<th>Corporate, Government Buyers</th>
</tr>
</thead>
</table>

#### Policy and Market Options

- **Research and development funding**
  - Promotion of new technology

- **Standards, code of conduct, or labeling programs for power supplies**

- **Utility incentives**
  - Labeling programs for finished products

- **Utility incentives**
  - Preferential marketing & retailer training

- **Utility incentives**
  - Promote energy savings, convenience

- **Utility incentives**
  - Promote smaller size and weight, savings in shipping, stocking costs

- **Promote lower total cost of ownership**
  - (energy savings, non-energy benefits)
  - Preferential government procurement
Do We Need Standardized Efficiency Curves?

- Power use at 0% load
- Efficiency % at 25% load
- Efficiency % at 50% load
- Efficiency % at 75% load
- Efficiency % at 100% load
Efficiency Curves of Equal Output Power Supplies

- ZIP 100 Small Switching Power Supply
- ZIP 100 Large Transformer
Focus on Non-Energy Benefits!
Key Market Advantages for Highly Efficient Power Supplies

• Reduce travel weight & size
• Free up outlets / increase convenience
• More units per shipping container & more room for merchandise in store
• Already meets existing standby and pending active mode efficiency specs – future-proof!
Price vs. Value Propositions

**Goal: Lowest Price**
- Take cost out “at all costs”
- Quality and reliability can drop
- No product differentiation
- Least common denominator design: no features, no profits
- Penny-wise/pound foolish – what saves the buyer $1 up-front can add $10 or $20 to lifetime energy costs
- All of us pay more – higher energy bills, more air pollution, more new power plants and power lines

**Goal: Highest Value**
- Emphasis on clever design and differentiation: multiple viable paths to success
- Minimize lifecycle cost: purchase price + lifetime maintenance, energy, & pollution costs
- Specs, labels, and utility programs help build a message of value: “may cost more, but worth more”
- Products more desirable – smaller, quieter, cooler, more convenient