Key lessons

- Information and communication technology is a major consumer of energy in offices
- Careful server room design and technology selection can provide large reductions in energy consumption
- Blade servers consume less power than standard rack servers
- Laptops consume less power than desktop computers, though some ergonomic issues may need to be addressed

Introduction

Information and communication technology (ICT) is a major consumer of energy in commercial offices. Estimates across the commercial building sector have found that ICT uses, on average, about 7-9% of a property’s total energy [1]. However, this figure can be much higher for some organisations. Computers, office equipment and servers can use up to 56% of the energy consumed by some office tenancies in the government sector (see Table 1) [2].

ICT system optimisation can have a number of benefits, including reduced energy consumption and reduced capital costs from more efficient use of computer equipment.

These issues were carefully considered during the fit-out of Sustainability Victoria’s office at Level 28, 50 Lonsdale Street in Melbourne. The organisation moved from three separate offices into the one new location, and in the process had the opportunity to review and optimise its ICT systems.

Table 1 – Energy consumption pattern in typical government office [2] (note that these figures are tenancy-only, and do not include base building apportioned energy)

<table>
<thead>
<tr>
<th>End use</th>
<th>Total power consumption (kWh/year)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>25,570</td>
<td>22.8%</td>
</tr>
<tr>
<td>Supplementary air conditioning</td>
<td>20,034</td>
<td>17.9%</td>
</tr>
<tr>
<td>Domestic hot water</td>
<td>1029</td>
<td>0.9%</td>
</tr>
<tr>
<td>Equipment (total, includes all the categories below)</td>
<td>65,595</td>
<td>58.4%</td>
</tr>
<tr>
<td>Office equipment and servers</td>
<td>45,497</td>
<td>40.5%</td>
</tr>
<tr>
<td>Computers</td>
<td>17,360</td>
<td>15.5%</td>
</tr>
<tr>
<td>Refrigerators and freezers</td>
<td>812</td>
<td>0.7%</td>
</tr>
<tr>
<td>Refrigerated drink dispensers</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Hot water units</td>
<td>1,926</td>
<td>1.7%</td>
</tr>
<tr>
<td>Chilled water units</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Total</td>
<td>112,228</td>
<td>100%</td>
</tr>
</tbody>
</table>
Servers

Before moving to its new floor at 50 Lonsdale Street, Sustainability Victoria commissioned Sinclair Knight Merz (SKM) to carry out a review of the organisation’s ICT systems. It was found that across the organisation’s three office sites, ICT was responsible for up to 75% of office energy consumption. 60% of that amount (ie: 45% of the total) was being consumed in server rooms. Servers in two of the three offices were also due for replacement under the organisation’s scheduled replacement strategy.

Hewlett Packard was commissioned to provide a report assessing the processing utilisation of the servers. The report found that the servers were using very little of their total processing power – none were using more than 25% of their capacity, and some were using as little as 5%.

It was originally anticipated that at least 20 servers would be required for the new office. SKM’s review found that it would be difficult to meet the Green Star and Australian Building Greenhouse Rating (ABGR, now NABERS Energy) requirements for the new office if the existing technologies were used. Based on this server model, SKM’s report estimated the server infrastructure required for the new office would consume 122,425 kWh/year. This would have equated to only a 2.5 star ABGR.

To address some of these problems, blade servers were selected for the new office. Unlike standard rack-mounted servers, blade servers do not contain power, cooling and networking components. Instead, multiple servers are installed in a cabinet or chassis which provides these functions for all the servers it contains. This means the servers take up less space, generate less heat individually and can operate more efficiently.

While a single blade server may cost more than a conventional server, their selection allowed for other immediate economic benefits at the Sustainability Victoria office.

As many of the old servers were only using a fraction of their total processing power, it was decided to consolidate a number of non-exclusive applications and virtualise some exclusive applications. This allowed the total number of servers to be reduced.

A conservative approach to uninterruptible power supply (UPS) sizing was taken as well. UPS units were sized based on server nameplate power requirements, but allowed for forecast growth and uptime (the norm is often to oversize UPS units).

The servers also come with monitoring tools which can provide information on how to reduce the power consumption of non-critical servers on nights and weekends. Plans for implementing these power reductions, as well as other technology solutions, were being examined at the time of writing.

At the time of design (August 2005) estimated power consumption based on this configuration of consolidated blade servers and smaller UPS units was 57,139 kWh/ year: 53% lower than the original estimates.

For every kilowatt of energy saved in the server room there is a direct reduction in the amount of air conditioning required. As the blade servers take up less space than conventional ones, and smaller UPS units have been used, the overall size of the server room (and therefore the space that needs to be air conditioned) was also reduced. Overall this allowed an estimated 35% cooling energy reduction.

Further cooling energy savings were made by raising the temperature set point of the server room.
Often server rooms are kept at a temperature of around 20°C, requiring a supplementary cooling system to run around the clock. Sustainability Victoria’s server room is being kept at 26°C, however, allowing it to operate on the base building air conditioning between 7am and 7pm on weekdays.

A dedicated water-source heat pump keeps the room at 26°C outside of these times. Keeping the room at a higher temperature (which is still within the operating temperatures allowed for under the server warranties) has allowed for substantial cooling energy savings.

Operational data has proved these measures to be very effective. In March 2007, when 90% of the organisation’s applications had been moved onto the new servers, actual server infrastructure power consumption was measured at 39,000 kWh/year - 68% lower than the original estimates.

**Sustainability Victoria infrastructure**

- One IBM blade chassis
- 14 blade servers (one for virtualisation development, and one as a cold server standby)
- One IBM X346 server for backup and other utilities
- One IBM DS4700 storage unit
- One IBM tape library
- Two APC 5KVA uninterruptible power supplies

System design: IQT Systems, Southern Cross Computer Services, IBM

### Desktop computers

At the organisation’s old offices, many staff used standard desktop computers. As part of the 50 Lonsdale floor fit-out, all of Sustainability Victoria staff now use laptops.

Reduced energy consumption has been the major reason for this change. A typical desktop computer with a flat screen uses 190W, but a typical laptop only uses 100W [3]. These figures include an 80W allowance for the energy used by peripherals (printers, faxes, etc).

Sustainability Victoria has targeted even lower energy consumption. The normalised equipment load for a workstation at Level 28, 50 Lonsdale is operating at 95W for staff using laptops (with 30W for the laptop itself, but only 65W for peripherals, which is a 5% overall reduction compared to the standard).

A separate keyboard and a mouse have been provided at every workstation for ergonomic reasons. The move to laptops has also provided some flexibility benefits for staff who can now take their computer to meetings or away from their desk when required. Being able to take their laptops to meetings also means that staff reduce the amount of paper used for note-taking.

### Automated power-down

Another fit-out innovation has been the use of a zoned master general power outlet (GPO).

The GPO automatically shuts off power to office equipment such as computers, printers, copiers and appliances to ensure they are not consuming energy outside of office hours. The shut down operates from 7:00pm to 7:00am on weekdays, and from 7:00pm Friday night until 7:00am Monday morning, for a total of 108 hours every week.

Certain items such as refrigerators and the server room have been excluded from the system for operational reasons, and individuals can override the shut off in their zone if they need to continue working outside of office hours.

It was estimated that this system would reduce office equipment energy consumption by around 2.59 MWh/year (see Table 2 for details).
Table 2 – energy consumption reductions from automated GPO shut down

<table>
<thead>
<tr>
<th>Item</th>
<th>Power reduction per item (W)</th>
<th>Power reduction per item per week (kWh)</th>
<th>Power reduction for all items per week (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brother Fax 2850</td>
<td>6.5</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>HP Laserjet 2100 TN</td>
<td>13.7</td>
<td>1.45</td>
<td>1.45</td>
</tr>
<tr>
<td>Xerox Document Centre</td>
<td>8.4-8.8</td>
<td>0.47</td>
<td>0.47</td>
</tr>
<tr>
<td>HP Laserjet 4250 printer</td>
<td>9.8-10</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>Smeg microwave</td>
<td>4.0</td>
<td>0.43</td>
<td>0.83</td>
</tr>
<tr>
<td>The Billi</td>
<td>3.9</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Hot water unit</td>
<td>4.0</td>
<td>0.43</td>
<td>0.43</td>
</tr>
<tr>
<td>Laptop computers</td>
<td>3.1</td>
<td>0.33</td>
<td>41.85</td>
</tr>
<tr>
<td>Desktop computers</td>
<td>1.8</td>
<td>0.194</td>
<td>1.94</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>50.77 kWh/week</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>2.59 MWh/year</strong></td>
</tr>
</tbody>
</table>

Challenges

Several hurdles needed to be overcome in the design of Sustainability Victoria’s ICT system.

Initially, some problems were encountered with computer hardware vendors. When the system was being designed in 2005-2006, the computer hardware industry and most vendors seemed to be focused solely on system performance rather than sustainability issues such as energy consumption. A number of vendors were consulted without success before IBM was contacted and was able to provide a suitable system.

Server hardware is continually being improved, however, and since the design of the Sustainability Victoria system many vendors have begun offering more sustainable server products. In particular, much greater attention is being given to energy efficiency.

Additional server cooling energy savings could have been achieved if it were possible to locate the server room on the perimeter of the building, allowing external ventilation through a side wall. 50 Lonsdale was already completed when Sustainability Victoria moved in and all external walls had been glazed, so it wasn’t possible to incorporate these measures. Companies designing a new building, however, would be in a position to consider measures such as this.

As part of a continuous improvement process, plans were made for further reductions in energy consumption by shutting down servers not required outside of work hours. This plan had to be delayed until data from the server monitoring tools could be interpreted by experts, and this was implemented at the time of writing.

Ergonomics and occupational health and safety challenges needed to be addressed when moving staff over to laptop computers. The separate keyboard and mouse provided at each workstation was a partial solution to this problem. Customised stands for the laptops also needed to be designed so that screen height could be properly adjusted and Green Star requirements for ergonomics and glare control could be met.

Conclusion

ICT is a major consumer of energy in office buildings. Many strategies are available for reducing ICT energy demand, however, both in the server room and on the office floor.

The basic principles used to design Sustainability Victoria’s server room at Level 28, 50 Lonsdale Street can be applied to any other location. Consolidation has allowed for the total number of servers to be reduced, and the use of blade servers has allowed for space, energy and infrastructure savings as well.

While some initial ergonomic and occupational health and safety issues may need to be overcome, a change from desktop computers to laptops can also significantly reduce energy consumption, and provide a variety of additional benefits.

The Sustainability Victoria case study package

Sustainability Victoria has developed a series of case studies to tell the story of our fit-out. The package provides an overview of our fit-out plus four technical sheets: Information and Communication Technology, Lighting, Waste, and Materials. The package can be downloaded at www.resourceSmart.vic.gov.au.
References
1 – Centre for International Economics; Capitalising on the building sector’s potential to lessen the costs of a broad based GHG emissions cut, report prepared for ASBEC Climate Change Task Group, published September 2007 and available from www.thecie.com.au
2 – Results of private study of government office energy consumption patterns, carried out by Sustainability Victoria in 2006

Further reading
Sustainability Victoria - www.sustainability.vic.gov.au
Your Building - www.yourbuilding.org

Building details
- Building name: Urban Workshop
- Address: 50 Lonsdale Street
- Fit-out cost: $2.02 million
- Total floor area (NLA): 1650m²
- Number of storeys: One (28th floor of building)
- Owner occupier / tenant: Tenanted
- New or refurbished: New
- Construction time: Two months
- Delivery method: Design, document, tender, construct
- Green Star Office Interiors rating: Rating TBC at time of writing
- NABERS Energy rating¹: Five stars

Project team
- Client: Sustainability Victoria
- Project manager: Gallagher Jeffs
- Architect: Hassell
- Environmentally sustainable design consultant: Sinclair Knight Merz
- Services engineers: Umow Lai
- Specialist solutions consultant: Energy Conservation Systems
- Quantity surveyor: WT Partnership
- Builder: Waltons

About Sustainability Victoria
Sustainability Victoria is a statutory authority that helps communities, businesses and governments to reduce their environmental impact, turning policy into action. Its new office on Level 28 of the Urban Workshop, 50 Lonsdale Street, Melbourne demonstrates that excellence in sustainable office interiors can be achieved within a typical commercial fit-out budget.

¹ Formerly Australian Building Greenhouse Rating (ABGR)