Oregon Sustainability Center
Information Technology Advisory Board (ITAB)

Recommendations to Design Team
February 2011

OSC ITAB Recommendations February 2011

Information Technology Advisory Board (ITAB)

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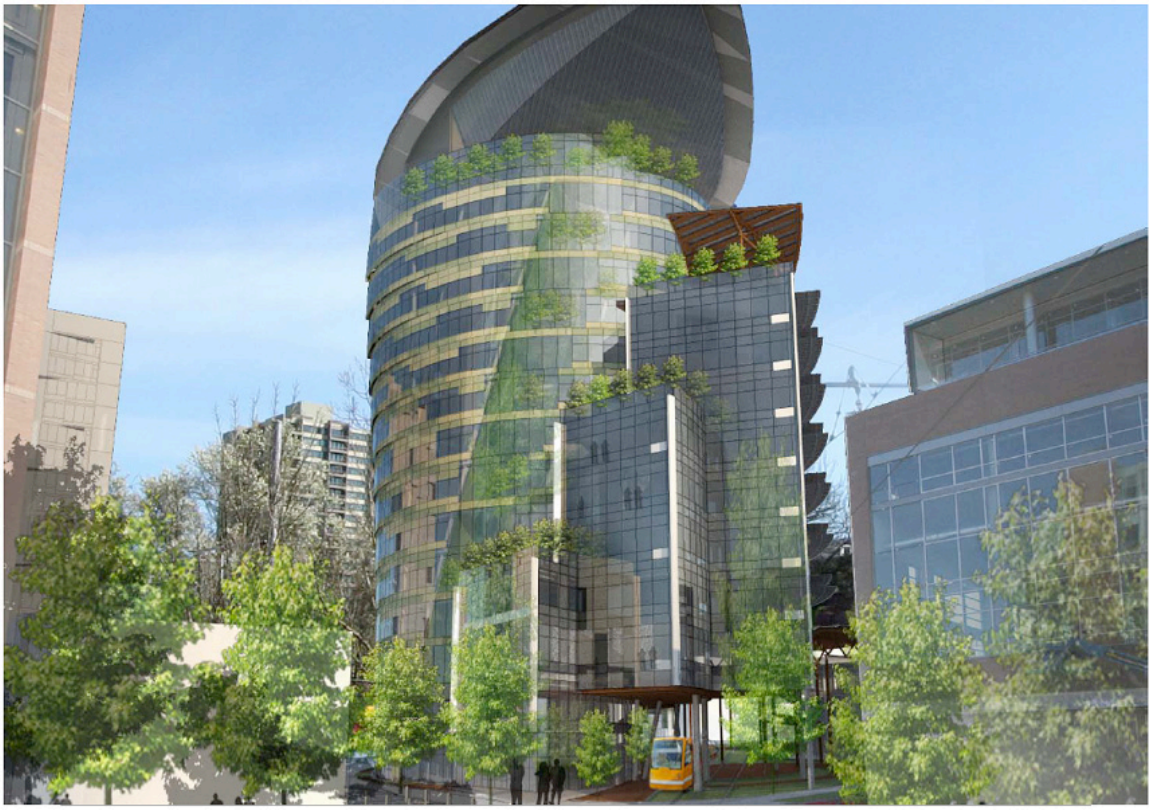

The Oregon Sustainability Center

The Oregon Sustainability Center (OSC) is an ambitious building project that will create the world's first urban scale Living Building in downtown Portland, Oregon. Based on the International Living Building Institute's Living Building Challenge 2.0 (See http://ilbi.org/) the building attempts to balance energy, water, and waste so the building has a "net-zero" or "net-positive" operation. The building is currently under schematic design and envisioned to be roughly 150K square feet and support 500-600 office workers as well as public spaces and classrooms.

The broader goal of the OSC is to create a world-class center of sustainability that celebrates and nurtures the values and strengths of Oregon's leadership in climate change, land use planning, smart-growth, green building, environmental stewardship, civic engagement, and social justice.

Anticipated tenants of the building include The City of Portland, Portland State University, Oregon University System, a group of non-profit tenants known collectively as the Oregon Living Building Initiative (OLBI). The anticipated tenants have formed a board that directs the activities and implementation of the project.

Information Technology Advisory Board

In July 2010, the OSC board authorized the formation of the OSC IT Advisory Board (ITAB) to assist OSC in creating an IT plan for the building. The high level goals of the ITAB are:

- To create a world-leading IT plan that enables the OSC mission focused on sustainable energy, water and carbon emissions reduction
- To design a compelling platform for public and business sector organizations to prove new sustainable technologies and best practices, on a startup and ongoing basis
- To attract world-leading organizations to contribute to the effort with their best talent, generating nationwide/worldwide visibility
- To provide unbiased, independent input to the OSC design and development team.

The IT Advisory board consists of a small group of IT and building professionals, dedicated to making OSC a success. Members include:

Charlie Kawasaki, CTO, PacStar, Co-Chair
Mark Gregory, AVP Portland State University, Co-Chair
Rich Bader, CEO, EasyStreet
Lisa Petterson, Associate, SERA Architects
Bob Trismen, Independent
Amy Hesse, Portland State University

This team has, to date, primarily focused on IT-specific energy issues and in the recruiting of IT industry representatives to assist in the general planning of IT in the building. This group has not focused on building systems, per se.

OSC ITAB Tenant Interviews

In October and November of 2010, the ITAB conducted a series of interviews with IT representatives of six of the prospective tenants of the OSC, to assess IT requirements. These interviews were conducted by Bob Trismen. High level points of the feedback include:

- Anticipated tenants currently have a mix of Windows and Mac based computers, with laptops comprising about 66% of users.
- Several tenants currently have their own IT infrastructure (servers), but all are migrating to cloud services and are open to managed hosting or collocation solutions.
- Significant high-volume, high quality printing capabilities are used, in-house for printing materials for outreach purposes.
- The tenants have limited in house IT staff.
- Average workstation use was estimated at 28 hours per week.
- VTC and other collaboration technologies are interesting, in use by some tenants already, and seen as reducing commuting and business trips to a varying degree.

ITAB Charrette

On December 8, 2010, the OSC ITAB held a design charrette meeting with the following objectives:

- To convene world-leading sustainable IT subject matter experts with building end-users, to create recommendations surrounding best IT practices as input into the building design process.
- To develop a list of the best ways to save energy and reduce/limit associated energy-saving costs
- To identify strategies/technologies that users can "live with" – i.e., determination of the "livability" constraints

In its essence, the objective of the charrette and the ITAB was to further the development of an enterprise IT architecture that IT vendors endorse, that tenants can live with, and that meets power budget and cost requirements.

The ITAB and Charrette have served as vehicles to secure the engagement of key IT industry players, in order to further take advantage of the growing expertise in this field, to keep abreast of emerging technologies, and to secure equipment sponsorship and future technology trials as appropriate.

The Charrette and surrounding IT vendor recruiting effort was extremely successful, securing active engagement and attendance from the following key industry players:

- Cisco
- HP
- IBM
- Sharp Labs
- Intel
- Sanyo
- Verdiem
- PacStar
- EasyStreet

Together with representatives from tenants, OSC project sponsors, OSC architects and engineers, the Charrette generated lively discussions and considerable input.

This report and its recommendations are based on ITAB ongoing work, Charrette presentations and group discussions of attending experts in the field, and input from project sponsors and tenants. It represents an ongoing investigation of best practices for new and future green IT technologies, combined with user feedback.

Energy/IT Challenges

In designing the Oregon Sustainability Center, we are faced with a unique set of challenges with regard to energy use. In a typical building, 30 percent of energy is committed to plug loads, which comprise all appliances connected to electrical sockets such as office work-space equipment, lighting, phones, IT infrastructure, etc. Given the innovative energy-efficient design of systems such as heating, cooling, and lighting, the largest factor in the Oregon Sustainability Center's electrical energy consumption will be plug loads. With tenant engagement in energy conservation, an estimated 48 percent of the building's final energy use will be represented by plug loads. Of the plug loads, 48 percent will come from laptops, desktops, and monitors. Since plug loads are largely related to occupant behavior and appliance usage, this presents great challenges as well as opportunities for energy use reduction.

Early estimates of power consumption by plug-load device type break down as shown in Figure 1. While total estimates of kilowatt hours per year (kWh/Y) may be reduced with the modest downsizing of the building, the relative proportion of consumption is indicated here, and shows laptops, PCs, Monitors, and Datacenter equipment as key areas to target for energy reduction. Further analysis, based on tenant interviews, also suggests that printers are a target area (although not estimated correctly here).

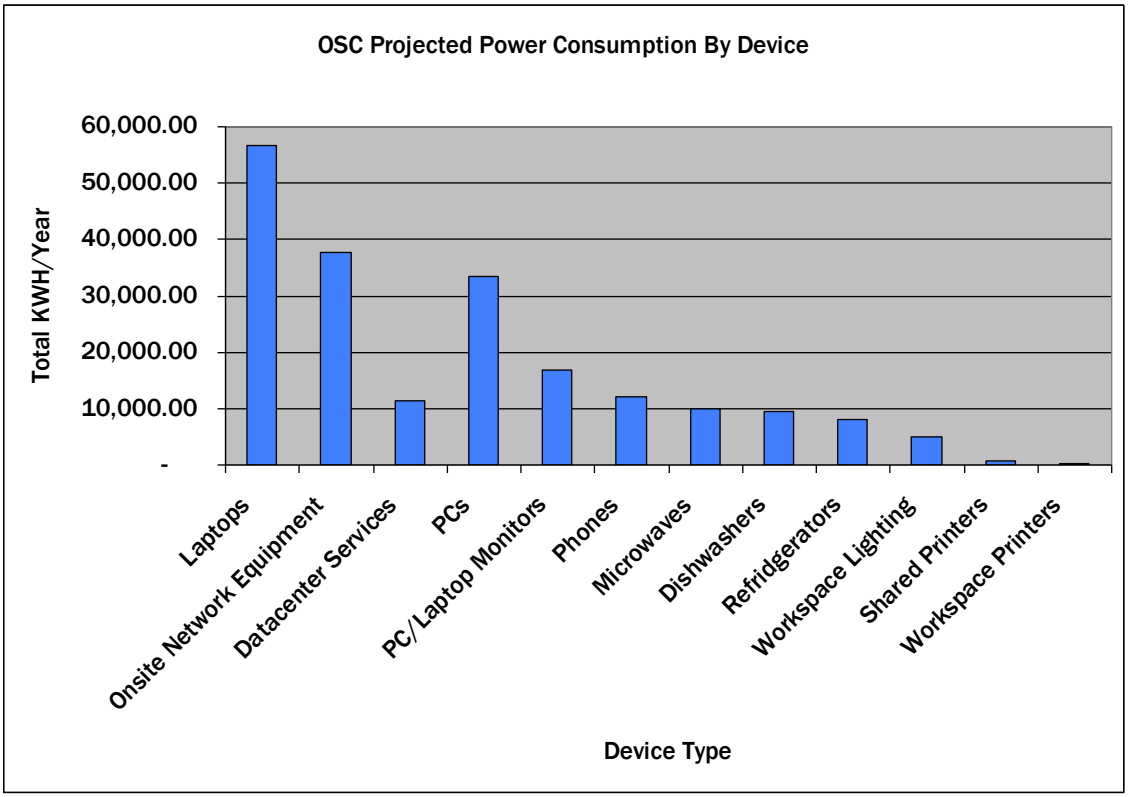

Figure 1. Relative Power Consumption by Device Type

Several additional proposed facilities in the OSC such as centers of excellence, VTC centers, educational centers, and public displays have included (or imply) significant video display installations. Current video display technologies designed for retail/public displays pose a further burden on the overall power budget of the building, as indicated in Figure 2, the graph of power consumption by size of several hundred monitors.

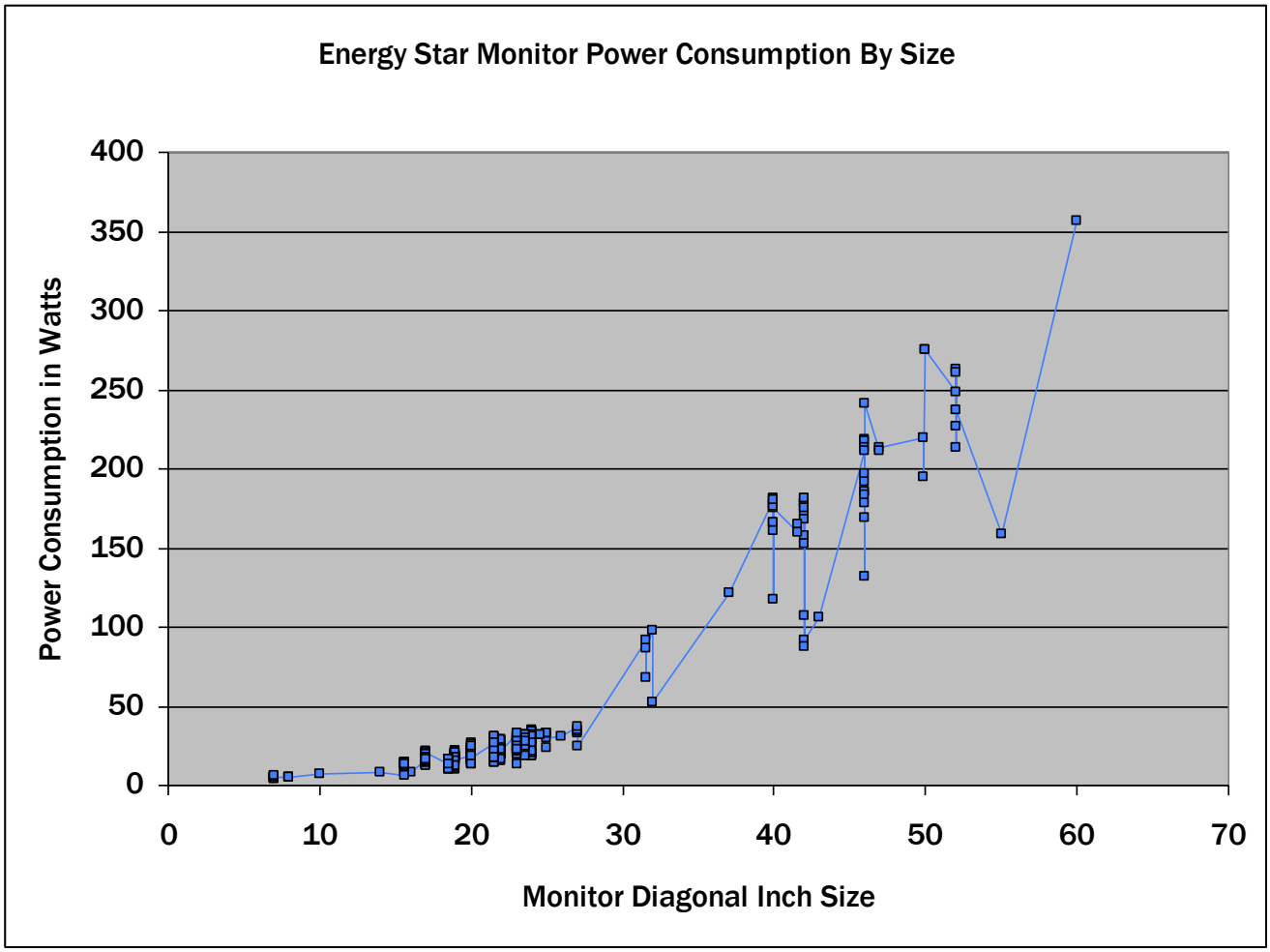

Figure 2. Monitor Power Consumption, By Size

Figure 3 below shows an additional 3rd party representation of the estimated average power wasted by a variety of IT devices, nationally, by percentage.

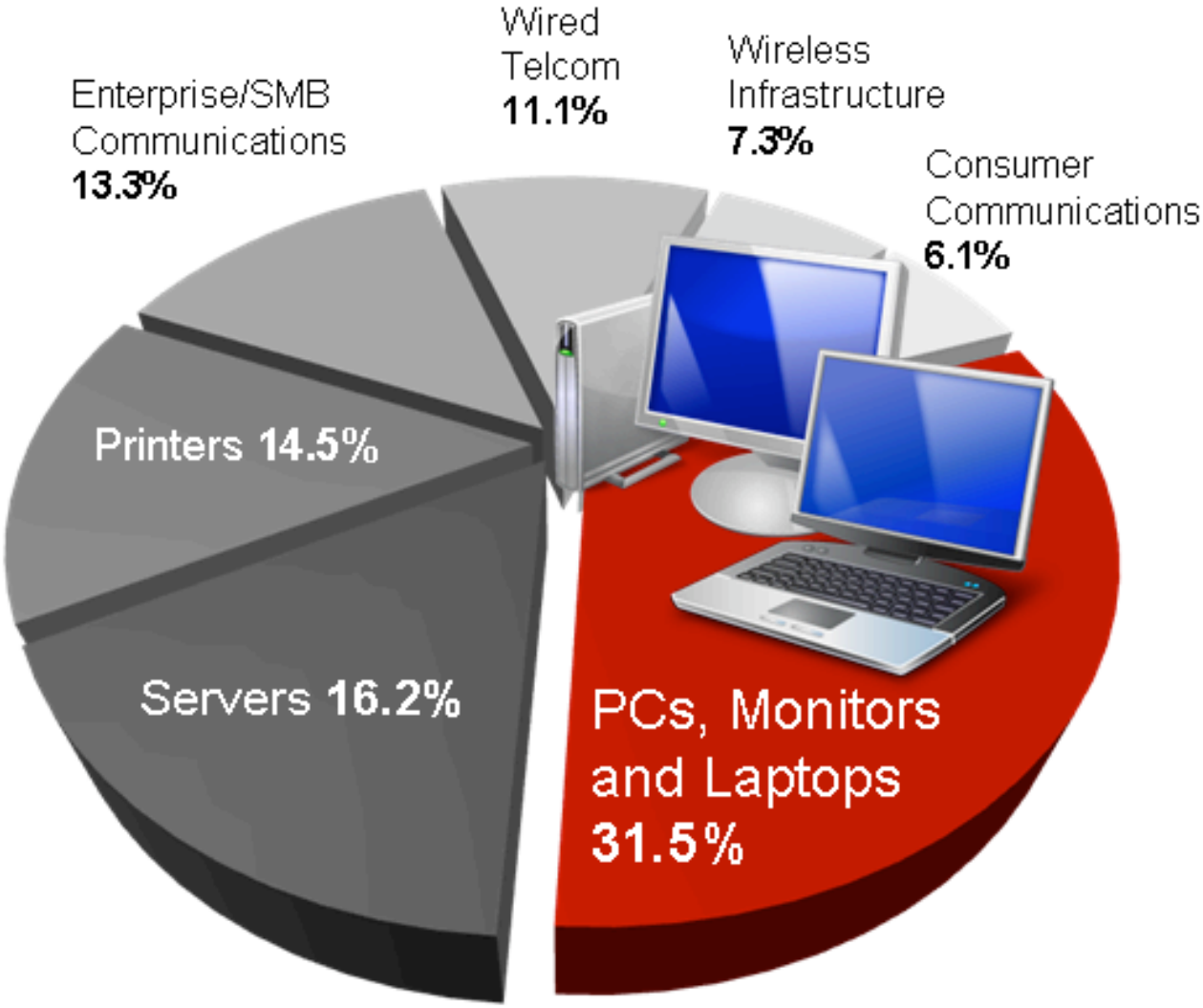

Figure 3. Relative Power Wasted by Device Type – Courtesy Verdiem, Inc.

The current estimated cost of photovoltaic cells, the infrastructure to support them, along with installation costs, nets out to approximately $7.25 PV watts per square foot. The high cost of the power generation puts substantial pressure on the financial viability of the building, which must be managed in order to prove the OSC concept. As such, adopting policies to manage the power consumption at the plug load is paramount to the success of the project, and requires substantial engagement by tenants to achieve. The device types above represent the "big win" items that ITAB recommends are addressed first.

Near-Term Implications for Tenants

The ultimate success of OSC's ability to meet its goals will be determined by many factors, including building systems, PV design, building architecture, materials selection, and tenant engagement. In order to meet OSC goals, it is clear that energy consumption must be aggressively managed, and that management necessitates the creation of IT Policies that are above and beyond standard office building practices of today. The ITAB has not engaged in sufficient levels of engineering, behavior analysis and technology assessment to make firm recommendations on highly advanced technologies, and therefore has sorted our recommendations into two phases – "mandatory minimums", and recommendations for further research into advanced concepts.

Due to the financial considerations and long purchasing cycles of IT equipment, ITAB has been asked to provide initial guidelines well in advance of tenants moving into the building, so that tenants know the rules regarding computer equipment, office appliances, individual servers, software systems, and overall energy use and behavior and can plan accordingly.

Mandatory Minimums, by Technology

The current ITAB recommendations for minimum adoption for tenants are as follows:

Laptops and Displays

Computers and their related displays represent a very large percentage of the power budget. Tenants are required to purchase Energy Star rated laptops and if required, Energy Star rated monitors. Tenants must configure the equipment to meet Energy Star energy savings guidelines, including configuring equipment to enter auto-power save modes on idle.

As of 2011, the OSC power guidelines for laptops is 42 watts of power draw or less. Desktop form factor towers are prohibited, with the special exception for high-end engineering or other professional requirements which may be subject to an OSC review/waiver requirement and to power budget constraints. External monitors may be added to laptops, so long as they draw no more than 20 watts (currently, that allows an average 20 inch Energy Star display to be used).

ITAB believes this is a generous allowance that will meet the demands of the most power-intensive users, particularly as new generation energy efficient processors and solid-state hard drives become more common. This 42 watt limit should be sufficient to host even the most demanding applications such as HD VTC.

ITAB also believes that in the future, as equipment becomes more energy efficient, this power budget may be revised downward for new equipment purchases.

Laptop and Display Power Management

As a condition of occupancy, OSC will require tenants to comply with energy management rules for laptops, displays and other devices, under the control of a central power management solution such as Verdiem Surveyor, Cisco EnergyWise, etc.

Recent studies have indicated that with energy power management enforcement software, typical office building may save up to 55% of laptop energy usage. The OSC energy budget has been designed with this level of savings assumed.

Laptop PC "On" Times
Effect of Power Management by Day & Time

Total Sample Industries: Laptops % of Hours PCs are "On"				
	Baseline	Enforced	Point Chg	% Chg
Typical Week	59.7	33.1	-26.6	-45%
Workdays 8 AM – 5 PM	74.6	55.9	-18.7	-25%
Workdays 5 PM – 8 AM	56.4	27.2	-29.2	-52%
Weekends & Holidays	51.1	22.8	-28.3	-55%

Figure 4. Energy Savings with Enforcement

The selected power management software system must be able to provide a tool for data aggregation and general policy management. After an initial roll out, OSC may decide to allow tenants to individualize their policies, depending on their unique workplace needs. Prior to moving into the building, the tool should be used to estimate a baseline for each tenant.

It is assumed that the IT systems and desktop power consumption and power consumption at the plug load will be monitored and reported on closely via the central IT power management system – and possibly by the building management systems as well.

Of note: Current generation laptops in "suspend" or "sleep" mode draw very little power. Therefore ITAB believes that during working hours, laptops and displays will not need to be powered to the "off" state when not in use, but simply put into "suspend" mode. This will reduce the irritation of tenants with having to wait for laptops to power up/down. Cycle times should also be significantly faster with modern, solid-state drive based laptops.

Building Network/Voice Infrastructure

At a minimum, certain network infrastructure will be included in the building, and will be a shared resource in order to maximize efficiency and power consumption. The shared resources will be:

- LAN infrastructure (in particular PoE Ethernet Switching)
- Wireless LAN infrastructure
- Internet Access with Firewall
- PSTN phone gateway(s)
- Video/teleconferencing equipment

This infrastructure will be configured to support multiple tenants securely, but will be shared in order to eliminate the power inefficiencies inherent in tenants providing their own, duplicated equipment. Security will be maintained via appropriate VLAN and routing infrastructure.

It is assumed and strongly recommended that all "enterprise" phone services will be provided over "shared access" PoE low energy Voice of IP desktop phones, with a power budget of no more than 6 watts per phone. A well-designed phone infrastructure will be critical to power efficiency in the OSC.

Datacenter Services

The method of accounting for power consumption by hosted and/or cloud services has not currently been addressed. Two major tenants (Oregon University System and City of Portland) will have major usage of offsite servers, and that offsite energy usage will be factored into the energy use of the building.

Using the most current "Virtual Machine" technologies that maximize the utilization of the server resources, OSC ITAB is recommending a budget of 3.3 watts per person for datacenter services including servers and storage. This budget will be proven through the implementation of highly efficient server configuration located either at OSC or at a high-efficiency off-site service provider, and will serve all tenants that would otherwise bring servers onsite. This implementation may serve as the benchmark for allocating power budget across tenants, such as the OUS and City of Portland.

Any tenant bringing server equipment into the facility, or using additional outsourced resources, may need to document their server-base power utilization, demonstrating that it meets the 3.3 watts per person budget.

Although the ITAB has not finalized a policy related to datacenter efficiency, the 3.3 watts per person budget may be adjusted by OSC to incorporate "Power Usage Effectiveness" (PUE) ratings, and may require the datacenter power budget to account for PUE. Incorporating this factor into datacenter power budgets will imply that hosted services will need to reside at ultra-efficient facilities.

The combined Datacenter and Network Infrastructure budget is 16.4 watts per person, and variances to OSC required architecture must demonstrate compliance with this power consumption limit.

Printers

Specific printer power consumption maximums have not yet been established by ITAB. However, the ITAB anticipates that the following guidelines will be adopted:

- Shared high-efficiency printing/multi-function device stations will be provided for tenants, with a maximum of a 50 foot distance from any desk
- Shared printers will be configured to initiate print jobs using authenticators, to avoid the problem of jobs sent but never retrieved from printers, and to increase the privacy of printed documents
- All printing and multi-function devices will have an auto on/off function to conserve energy, and will be managed by a central power management system
- Every effort should be made to reduce printed pages by configuring printers to use double-sided printing by default
- In addition, paper will be reused and recycled, and the paper with the highest recycled content or FSC certification used
- Some tenants may require high-efficiency private printers for the production of confidential documents. This will be allocated according to guidelines, TBD

Until such time as specific guidelines are adopted, when tenants need to enter into new printer contracts, tenants are encouraged to adopt Energy Star rated printers, with maximum energy saving capabilities, including the capabilities listed above.

Several tenants have expressed concern about their ongoing long-term printer/multi-function device appliance leases coming into conflict with Oregon Sustainability Center requirements for new, power-efficient equipment. This is still an open item for the team to address.

Other Sustainability Considerations

Sustainability is not just limited to energy consumption, and ITAB acknowledges this fact. In addition to power consumption, sustainability factors may include materials toxicity, geography of manufacture, recyclability, fair labor practices, and more. In the basic analysis conducted by ITAB, these factors were not considered due to energy consumption being the primary driver. Additional research is warranted on these factors, before final mandatory policies are enforced.

Recommendations Summary

- Tenants must plan on using only laptops operating under 42W, with few exceptions
- External monitors must operate using under 20W, 20 inches or less
- Tenant laptops, displays, and other devices must comply with energy management rules, controlled by a central power management solution
- During working hours, laptops and displays not is use must be put into "suspend" or "sleep" mode
- Land line phones will operate via "shared access" PoE low energy Voice of IP desktop phones, each operating at 6W or less
- Tenants are recommended an energy budget of of 3.3 watts per person for datacenter services, including servers and storage
- Combined datacenter and network infrastructure budget is 16.4 watts per person
- Tenants will use shared high-efficiency printing/multi-function device stations, at a maximum of a 50 foot distance from any desk
- All printing and multi-function devices must have an auto on/off function to conserve energy, as managed by a central power management system
- By permission, some tenants will be allowed high-efficiency private printers for the production of confidential documents
- When tenants enter into new printer contracts, they are encouraged to lease Energy Star rated printers, with maximum energy saving features as specified above

Future Technology Directions

Additional technology development, assessment, and pilots may provide substantial savings to the OSC power budget, and consequently improve the economic viability of the OSC. The ITAB and ITAB Charrette attendees discussed a myriad of approaches that should be explored further, either prior to building occupancy, or as ongoing pilots or living laboratories. The ITAB envisions OSC as a technology proving ground, center for technology demonstration, and business development activity, not just a static, one-time build.

The following items were discussed and proposed as useful, but they have not been "approved" as minimum recommendations at this time due to one or more of the following factors:

- lack of technology maturity at the date of writing
- lack of agreement that the policy is "workable" at this time, from a tenant perspective
- lack of resource to fully pursue by the volunteer ITAB

Each of the ideas below REQUIRE further consideration and analysis.

Cloud Computing/Thin Client Computing

"Cloud" computing or shared/hosted computing will be cost-effective and efficient for tenants with typical office IT use and for small non-profit organization tenants. The minimum architecture required by OSC ITAB will be high-density VM hosted architecture, with laptops for local processing. However, there are several variants to this model that have been discussed, including:

- Thin client computing, which may have lightweight processors and no (or limited) local storage
- Virtual Desktop, which may provide substantial computation on the server, rather than on the desktop
- Tablet computing, moving to ultra low-power tablet computers for typical office work

Some benefits cited for thin client computing include security, mobility of data, telecommuting, and allowance for a temporary workforce.

Concerns about these approaches include:

- Some tenants will require local, dedicated applications; for example, some engineering staff will need AutoCad. One to two tenants have users that compute intensively and will want remote access.
- ITAB and Charrette experts did not have sufficient understanding of the power consumption of virtual desktops, and were usurer of the accounting for power if the power draw was just being moved to the server
- Some people expressed concern about thin client, and whether the approach had enough flexibility and capacity to meet tenant IT needs

Shared workstations have also been suggested but most tenants have expressed that shared workstations are an undesirable workplace arrangement. The team may consider ways that these perceptions could be changed with clever design and a more appealing approach to marketing the concept.

Experiments with new architectures in this section may be best suited as pilots for select subsets of the building (possibly research and academic floors) , rather than as mandatory minimums, at this time.

Tenant Behavior Tools/Aids

A major part of the reduction of plug loads will be enabled by modifying tenant habits and behavior. A number of ideas have been discussed, but not developed to the point of recommendations. ITAB believes this is a rich area for innovation, but there has not been sufficient research by ITAB to generate recommendations.

Several ideas that have been raised in this category are:

- Providing tenants with access to computer or mobile device interfaces that provide engaging information regarding real-time energy use and tips to improve energy performance
- Providing tenants with metered energy budgets and incentives to reduce energy consumption below budget
- Creating competitive dynamics by sharing the energy performance of groups within the building.

ITAB believes this area has great potential for savings, and needs further research. Additional ITAB efforts and/or collaboration with vendors and Oregon University System researchers may be indicated.

Collaboration Tools and Telecommuting

It is assumed the OSC will contain at least one shared, enterprise-class Video/Teleconferencing facility. Teleconferencing will result in carbon emissions reduction associated with less business travel, as well as encouraging the use of the OSC as point of outreach, information sharing and communication.

In support of teleconferencing and telecommuting, many tenants should provide their employees with supportive policies and energy efficient ways of working via collaboration tools. The more days that employees work from home means fewer commutes and less burning of fossil fuel, as well as less impact on the building.

However, neither the OSC and ITAB, nor living building challenge, has created an accounting strategy for energy credits/offsets for transportation reduction or for offsite work. Therefore, ITAB has not factored these technologies into the ITAB plan in detail at this time. However, this is an area that ITAB believes must be addressed as part of the OSC, and as part of ecodistrict or regional approaches to sustainability.

Network Infrastructure/Power Infrastructure

Power over Ethernet (PoE) offers a low cost way to distribute DC power directly to consuming IT devices. Currently limited to 30 W – PoE is continuing its evolution. Some specialized companies claim to support more power now. The promise of delivering power over a single wire, capable of powering all workspace devices, is attractive when/if it is able to eliminate the need for AC wiring, and when it is able to eliminate the need for inefficient power conversion from AC to DC.

In order to meet these goals, PoE needs to:

- Deliver enough power for laptops and displays (without the need for additional converters)
- Deliver the power via PoE ports that are not prohibitively expensive – currently port costs run about $160 per port for entry level equipment
- Provide enough ports and power enough devices to enable the reduction of AC wiring

This is idea, along with the "DC-Loop" proof-of-concept idea, are excellent candidates for entire floor level pilots or efforts in limited areas in the building. The ITAB does not feel PoE is ready for full deployment, but it will likely play a key role in the future IT infrastructure of the building.

Advanced Workspace Power Management

The idea of using occupancy sensing – or proximity based technologies (RFID, Video Content Recognition, biometrics, etc.) to manage the power and environmentals for a workspace has been suggested. The benefits of this technology could include:

- More accurate power management – the devices will be less irritating if they power up as you approach them, and do not power down in the middle of your work
- More power savings – the devices may be smart enough to power down when you leave, rather than waiting for idle time interval
- More security - the devices may double as added security measures
- Statistics gathering on behavior – occupancy sensing combined with energy metering can become a tools to better understand how people are working in the environment.

The ITAB could not find standards based technology products that are ready to integrate with power controls at the time of writing, but feel this is an area that the OSC design team should re-examine before final workstation design is complete.

Advanced Printing/Imaging Technologies

The ITAB has not put significant efforts into exploring additional, advanced concepts related to imaging/printing. The Charrette attendees, with significant active involvement from HP, discussed numerous areas to consider related to sustainability, paper use, efficient printing, etc. Several ITAB members have also broached the possibility of technologies and encouragement user-behaviors related to paperless "printing" via tablet computers, meeting room displays, and printing to electronic paper. Some of these technologies, with further discussion on the part of ITAB and vendors, may be prime candidates for moving to the "Mandatory Minimums" category.

Tablets and Smart Phones

Tablets and smart phones, based on Apple IOS and Android platforms, have been experiencing a very rapid adoption and may be almost ubiquitous by the time the OSC is operational. The devices have very low power requirements, long run times, and increasingly can serve in place of larger computing platforms. These devices should be considered not only as a computing platform, but also as a possible printing alternative and a feedback/control interface for the work environment.

The OSC should consider how custom designed apps for use by building residents might assist in the behavioral feedback and statistical research needs of the building.

Note also that such devices will demand a robust wireless environment, including the possible need to add Distributed Antenna Systems (DAS) in the building. Portland State University's NTS department has familiarity with DAS systems and may be able to assist in power budgeting.

Building Implementation

The ITAB's charter has not included building systems. However, as a part of the natural intersection of IT and building control/systems, a number of ideas have been raised, and are captured here for consideration.

DC Loop

Considering that IT equipment natively runs on Direct Current (DC), experts have suggested the implementation of a building DC power loop to reduce the amount of energy lost in the conversion from DC to AC power and back again (in some cases, repeatedly). However, cost considerations may move this idea into the pilot/PoC category. The OSC team has discussed the idea of conducting pilots/PoCs for various technologies in a subset (i.e., one floor) of the building.

Building Control Backbone

The IT experts in attendance at the charrette discussed developing hybrid building systems that use both hardwiring (silo) and networking (single backbone).

Silo (Hardwiring)

(+) better understood by industry and vendors, more traditional
(+) the more contractors know, the less money it will cost to build
(+) if a router fails, silo has advantage of guaranteeing performance

Single Backbone (Networking)

(+) fewer materials on Red List (copper, PVC, etc)
(+) fewer systems to fail
(+) enables better remote management, smarter diagnostics
(-) more effort required for integration of systems

Following is a list of systems discussed for silo (hardwiring) and single backbone (networking) strategies.

<u>Network</u>
audio/video conferencing
audio/visual projection
voice
data
lighting (? TBD)
RFID-tracking (TBD)
video surveillance
access
digital signage
unified communications
mobility – remote access
wireless
operable windows (we may opt for manual, though)
web collaboration tools
link to PSU class schedule for classrooms

<u>Silo/Hardwire</u>
fire (TBD – codes may change)
BAS (energy)
elevators
HVAC sensors

Energy Efficient Datacenter/Networking

Engineers have suggested that OSC consider networking/datacenter equipment that can run at high ambient temperatures, in order to reduce the HVAC power requirements of the central IT equipment. While this idea has merit, the limits on available equipment and the extra costs have not been discussed by ITAB.

Kinetic Energy Storage

Advanced battery and/or Rotary Kinetic Energy Storage should be investigated as a means of providing power during low sunlight periods.

Flexible, Expandable Wiring

Charrette attendees remarked that the OSC should be constructed with extensive amounts of conduit or pathway systems allowing for many types of wiring, for flexibility for installation of future technologies.

Conclusions

To date, the ITAB, as an informal group, has successfully accomplished the following objectives:

- Provided power-budget recommendations to the OSC design team, regarding key IT equipment
- Generated recommendations for power consumption policies for the near term, for tenant related equipment
- Generated tremendous visibility/awareness and engagement in key IT vendors, regarding OSC
- Identified key future trends of technologies that should be explored, that can take advantage of OSC as a proving ground, and that provide economic development opportunities
- Identified key open issues that deserve further attention

Key open issues that should be addressed include:

- Policies for accounting for offsite datacenter services, including allocation of power and PUE factors
- Policies for taking advantage of reduction in commuting and business travel
- Policies/methods for engaging with vendors in proof-of-concept work on advanced technologies