PROTOCOL

FALL 2013 ■ VOLUME 18 ■ NUMBER 4

plasa Rock Our World awards 2013 FINALIST

Learn who wins the 2013 Rock Our World Awards at the PLASA Cocktail and Awards Reception, November 21 from 5:30 - 7:30 p.m., at the LVH Hotel. 30

The Long Reach Long Riders received a warm welcome on their visit to ETC in Middleton, WI and a full tour by CEO Fred Foster. 74

On the Cover:

Fisher Dachs Associates, in collaboration with Seattle Repertory Theatre, gathered 2011-2012 season data that would help inform environmental decision-making about stage lighting. Top row: Marya Sea Kaminski and Suzanne Bouchard in *Clybourne Park*, 2012, Photo: Alan Alabastro; Nick Garrison in *I Am My Own Wife*, 2012, Photo: Chris Bennion; Michael Patten, Anastasia Higham, Peter A. Jacobs, Elizabeth Raetz, and Gretchen Krich in *Circle Mirror Transformation*, 2011, Photo: Chris Bennion; and Lorenzo Pisoni in *Humor Abuse*, 2011, Photo: Chris Bennion. Second row: Linda Gehringer in *How to Write a New Book for the Bible*, 2012, Photo: Kevin Berne; Alban Dennis and Linda K. Morris in *Sylvia*, 2011, Photo: Chris Bennion; Mari Nelson and Linda K. Morris in *Sylvia*, 2011, Photo: Chris Bennion; and Basil Harris and Montana von Fliss in *Or*, 2012, Photo: Chris Bennion. Third row: Montana von Fliss and Kirsten Potter in *Or*, 2012, Photo: Chris Bennion; Lorenzo Pisoni in *Humor Abuse*, 2011, Photo: Chris Bennion; Kim Staunton and Teagle F. Bougere in *Clybourne Park*, 2012, Photo: Alan Alabastro; and Nick Garrison in *I Am My Own Wife*, 2012, Photo: Chris Bennion. Fourth row: Anastasia Higham in *Circle Mirror Transformation*, 2011, Photo: Chris Bennion; Aaron Blakeley, Tyler Pierce, Linda Gehringer, and Leo Marks in *How to Write a New Book for the Bible*, 2012, Photo: Kevin Berne; Denis Arndt in *Red*, 2012, Photo: Chris Bennion; Connor Toms and Denis Arndt in *Red*, 2012, Photo: Chris Bennion. 18

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Stage lighting and the environment: Results from a year-long study

BY KATIE OMAN

EVER SINCE WE BEGAN paying attention to ecological sustainability, stage lighting has seemed like a big environmental villain. Its offenses are many: hundreds of high-wattage luminaires for every show suggest exorbitant energy consumption. Inefficient tungsten lamps emit a lot of heat relative to the amount of light they produce and drive up air conditioning loads. This vilification has been compounded by proposed regulations barring the production of general service incandescent lamps, perpetuating the idea that stage lighting represents an environmental threat. As theatres and other performing arts venues have intensified their interest in environmental impact reduction, stage lighting has come under increasing scrutiny.

Despite these concerns, little data exists regarding the environmental impact of stage lighting for the theatre. Most theatre electrical systems are not sub-metered, and those that are rarely isolate the stage lighting to allow accurate power tracking. (If anyone is sub-metering their stage lighting, please contact me!) Close attention to energy consumption is uncommon in American cultural buildings. In the UK and the rest of Europe, cultural facilities are subject to more environmental scrutiny, but definitive measurements for performance lighting alone are hard to come by. As a result, the actual power use of stage lighting is largely unknown, and it remains an environmental bogeyman.

Up to now, most efforts toward reducing stage lighting's energy demand have been focused on switching from incandescent to higher-efficacy sources. Engineering advances have brought LED stage lighting products to the marketplace, and the energy savings they offer is used to justify their high initial cost. Although LEDs have only recently been applied to white front lighting, they have a long track record of success in applications where deeply colored gels reduce the transmission of incandescent light to a tiny fraction of its output. Their ability to emit highly saturated colored light without loss of luminous efficacy makes them attractive options for deep washes and accents. By and large, however, LED stage lighting luminaires remain very expensive, and little comparative data exists regarding luminaire efficiency or heat output that would allow us to compare them directly to conventional incandescent products.

The data support a case against eliminating tungsten lamps in the name of ecological sustainability.

A study to gather power use data

Theatre planning and design firm Fisher Dachs Associates, in collaboration with Seattle Repertory Theatre (SRT), conceived a project to gather data that would help inform environmental decision-making about stage lighting. It was a part of a larger study to identify a range of projects that would help the organization address ecological sustainability in achievable ways. These ranged from no-brainers (setting the printers and copiers to double-sided) to costly systems upgrades that could reap thousands of dollars in annual utility savings (replacement of aging air handling units). To examine the environmental effects of the stage lighting, we had to find a way to measure the energy it consumes.

Because sub-metering the stage lighting power feeds was impractical, we used the FocusTrack database to measure the stage lighting energy use over the season's eight productions in SRT's two spaces: the 250-seat Leo Kreielsheimer Theatre and the 850-seat Bagley Wright Theatre. The FocusTrack software, designed by Rob Halliday, records rig and cue input from the control console as well as other information such as focus areas, lamp use, and gobo and color data. Rob helped us optimize it to use the cue timing, channel levels, and rig data to calculate the electricity use for each cue and then for the entire performance.

As the season progressed, SRT's lighting department recorded detailed show data and tabulated the hours spent in focus and rehearsal onstage. We extrapolated each show's energy use throughout the number of performances and rehearsals and used that data to estimate the use during tech and onstage rehearsal. Although the data are

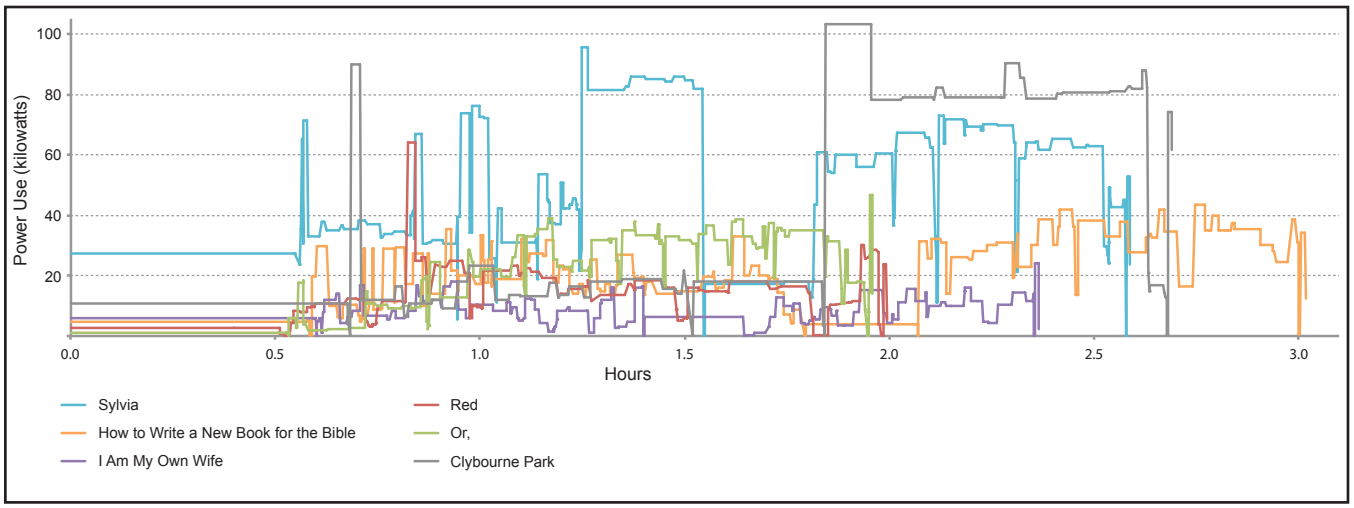

Chart 1 – Production power profile: Seattle Rep 2011-12 season

not the result of direct power metering, we believe they nevertheless give an accurate idea of energy consumption.

Results illustrate energy realities

The data offer a number of insights, both for individual shows and the season as a whole. At the study's outset, given stage lighting's reputation for energy-guzzling, we had some expectations about the results. First, we thought that energy use for the season would be so high that we'd be able to show how important it is to pay attention to the environmental impact of stage lighting. Second, we thought we'd get measurements that would help us calculate the payback period for LED stage lights. Third, we thought we might be able to justify replacing existing equipment with LEDs on the basis of utility cost savings alone. Turns out, it wasn't quite that easy!

Chart 1 above illustrates the stage lighting power use for six of the eight shows in the 2011 – 2012 season (for the first two productions, *Humor Abuse* and *Circle Mirror Transformation*, integrating cue-tracking was still in progress).

It's not only neat to look at but gives us a holistic representation of the power use for these productions. Perhaps most obvious is the enormous variability in power consumption between shows and from cue to cue. Though this variability might not come as much of a surprise to lighting designers, it's a valuable illustration of how much power consumption can vary even between productions of similar size and genre. The vast majority of the shows' power demands fall below 40 kW—only around 20% of the average total connected load and likely much less heat than the building's HVAC systems were originally designed to handle. See **Chart 2** for a comparison of each show's possible versus actual power use.

Further, conventional wisdom suggests that the curtain call will typically be the highest-energy cue in a given show. Though they are easily identifiable in the overall energy use chart, they show up only as brief spikes and don't come near rivaling many other high-powered cues. Examining the shows' periods of highest energy demand (in excess of 75 kW), we find that these are mostly cues where incandescent cyc washes were used at high intensities, and often with deeply saturated gel. This suggests that to reduce overall stage lighting energy use, higher-efficiency cyc lighting may be a good place to start. LED cyc luminaires are not new to the market, and although they remain costly as compared with incandescent strips, the lamp life is much longer, color media are not required even for highly saturated washes, and the dynamic color-control of the luminaires is attractive to designers.

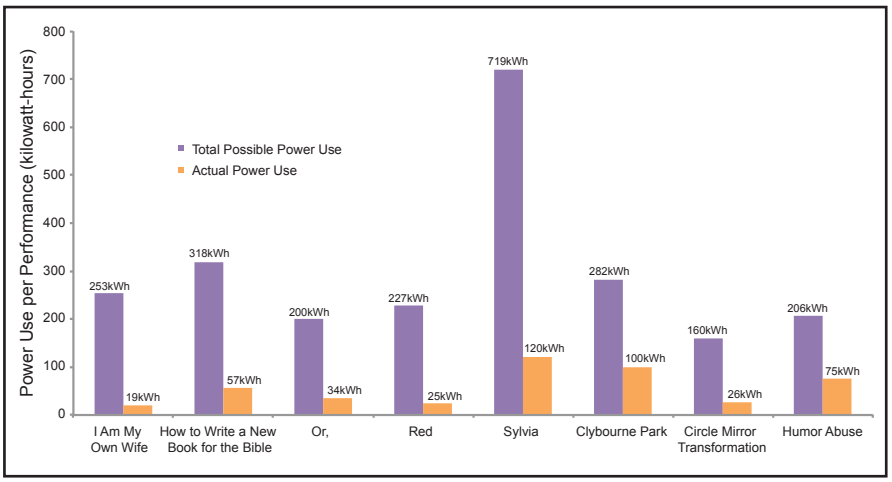

Chart 2 – Possible vs. actual power use

Comparing the power demand of these highest-energy cues also shows the large disparity between the power available and what is actually used. One might guess that the peak power draw for a particular production will be a large percentage of the total connected load. In SRT's 2011 – 2012 season, only *Clybourne Park*'s brightest cue used more than half of the total connected load, and the other shows used an average of 30% less as shown on **Chart 3**.

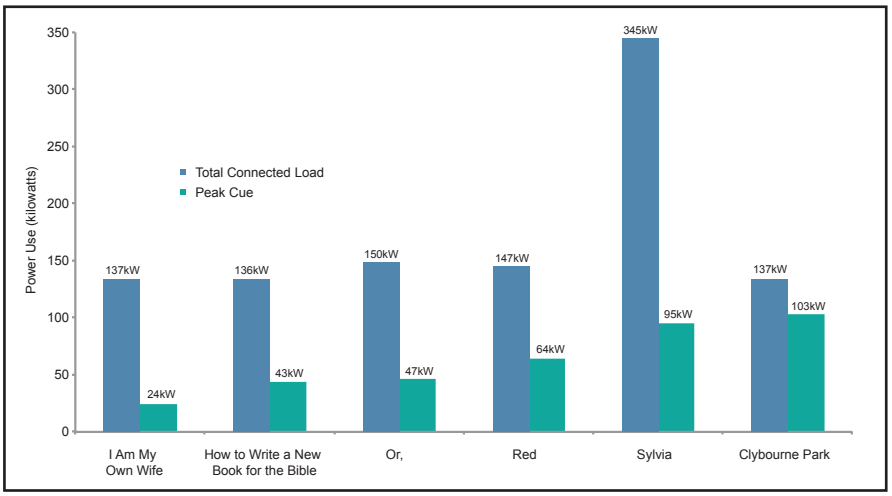

Chart 3 – Total connected load vs. maximum power draw

In the US, the economic implications of the availability of power in a building are confined mostly to new construction where reduced load forecasts might allow savings in the cost of electrical supply systems; we pay for power as we use it. However, in UK and other parts of Europe, building owners and operators pay not only for the kilowatt-hours they use but also an annual payment per megawatt of available power. In this case, an understanding of how power feeds can be minimized without affecting designers' artistic options could have important financial implications.

Examining the power use totals for the entire season yielded the biggest surprises. While we expected to discover that SRT was spending a fortune each year on electricity for stage lighting, the total power used by the stage lighting for the entire season came out to just under 25,000 kWh. Not only does this amount to less than $1,600 (using Seattle's commercial power rate of about $0.065 per kWh), but it also makes up only 2% of SRT's annual energy bill. Cutting the stage lighting power demand by 75% (a possibility offered by an all-LED rig) would not amount to an institutionally significant cost savings. In locations where power is more costly—in and around New York City the rate can be $0.19 or $0.20 per kWh—a $5,000 bill for the season would still remain insignificant relative to the rest of the building's energy costs. It should be noted that Seattle Rep's facilities are pretty typical for a regional theatre; the two theatres and their stages make up a large portion of the building, and while it houses scenic, costume, office, and rehearsal spaces, the lobbies are relatively small, and there is no restaurant on site. Thus, the building can't be characterized as an energy hog that would make the stage lighting power use look small by comparison. This only serves to underscore the insignificance of stage lighting's contribution to the total.

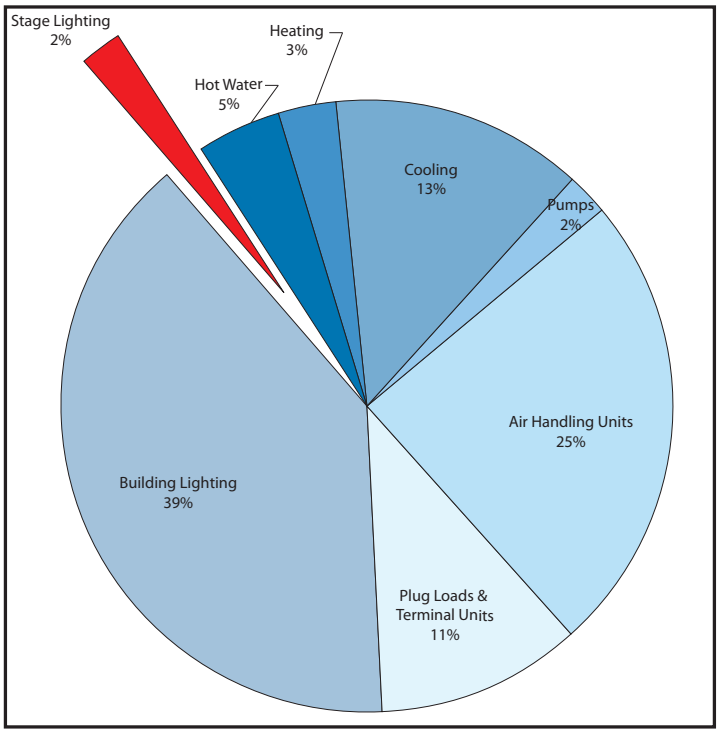

Chart 4 – Seattle Rep annual energy cost profile
***source: McKinstry Energy Audit 2010**

Taking into account the energy use of cooling systems that counteract heat gains from the stage lighting is a bit more difficult. Ignoring quiescent loads, the complexities of stage and auditorium cooling zones, and issues of thermal storage in maintaining comfort conditions, we can examine the sensible heat from stage lighting on the basis of its wattage alone. If, theoretically, cooling systems are always on during performances due to the heat loads imposed by the presence of an audience, we can assume that any reduction in heat from the stage lighting will result in a parallel reduction in the work required of the cooling system. During tech and rehearsal, in the audience's absence, the cooling systems

might not be engaged at all, and energy from the stage lighting would actually reduce the work required of the heating systems.

If the cooling systems' load resulting from the stage lighting systems during performances was reduced by 75% throughout SRT's 2011 – 2012 season (again using theoretical all-LED rigs), it might save about 34m Btu over the season, about 40% of the heat loads imposed by a conventional rig. The cost implications of these hypothetical savings are impossible to ascertain in the case of SRT because they use a central chilled-water cooling system that is shared throughout the Seattle Center campus. Further, Seattle's climate is relatively mild, so work required of the cooling systems will be far less than in hotter, more humid climates. The small cost of the entire season's stage lighting electricity use suggests that a partial reduction in cooling demand will not make a significant cost difference in the annual energy bills.

Changes in stage lighting sources in existing buildings ought to be made on the basis of artistic objectives, not energy savings.

However, the data does suggest that for a new building, significant capital cost savings could result from a reduction in the peak capacity of cooling systems, and therefore the physical size of those systems and the related space devoted to air supply and return. In performance halls requiring quiet HVAC systems with very low air velocities (and therefore large ducts), this space can add significantly to building volume and therefore drive many other costs higher. A close examination of the Rep's data shows that the median peak cue power is only about 30% of the total connected load, and the brightest cues last for an average duration of less than one minute, while the vast majority of every show is spent drawing much less power than the peak. This suggests that the stage lighting systems may be generating less heat than the building HVAC systems were designed to handle. Further data monitoring of stage lighting may inform more precise systems design and capital cost savings for new buildings and systems.

In new construction, these savings, along with the possibility of reducing dimmer capacity, could be enough to justify the cost of LED lighting equipment to outfit a new space. In spaces where the lighting is always on or where it drives a large cooling demand, such as broadcast spaces or concert halls, the payback equation may also favor using very-high-efficacy light sources. However, in existing theatres with existing systems, a large investment in high-efficiency stage lighting appears to have little chance of saving enough energy to pay for itself in a reasonable period. Taking into account cost savings from reduced lamp failure and gel use can improve prospects considerably, especially for cyc lighting, but saving energy through investing in high-efficiency sources is likely to be much more effective off-stage than on-. It would appear that theatres should invest in high-efficiency stage lighting equipment on the basis of benefits it offers to designers for color-control and quality of light.

So where do we go from here?

These findings need corroboration from other studies before solid conclusions can be drawn. However, the study does help set a direction for deeper inquiry into stage lighting's ecological profile. First, the data support a case against eliminating tungsten lamps in the name of ecological sustainability. While higher-efficacy sources will offer energy savings in certain applications (especially saturated color washes), a total switch to non-incandescent sources just won't make that much of a dent in a theatre's energy consumption. It would be better to replace lobby, shop, and circulation space lighting to reap the energy and cost savings and to worry more about patron transportation, waste management, building systems, and other more formidable environmental foes. Changes in stage lighting sources in existing buildings ought to be made on the basis of artistic objectives, not energy savings.

Of course we may find, with further analysis, that new facilities with all-LED rigs may be able to reduce the size of their air handling systems, and thus see capital building and equipment cost savings significant enough to justify the cost of the luminaires. Likewise, in applications where access to power is a problem, or where energy costs make up a bigger portion of the total costs of production, it may be possible to make the case for a more reasonable payback period on an energy-efficient lighting investment. However, relying on energy use reduction from luminaire choice alone may not register as more than a blip on the annual utility bill.

The relative size of stage lighting's environmental impact frees us from thinking of it as an ecological villain that we have to hide from or apologize for. Theatres around the world have made great strides in reducing their energy use by simple building upgrades that don't affect the work onstage. In fact, prior to this study, SRT upgraded almost all the architectural lighting throughout the facility to use energy-efficient lamps, resulting in an estimated energy savings of more than 100,000 kWh, or about $6,000 per year. The Grand Theatre in London, Ontario has changed all of its building lights to LED or compact

fluorescent sources and has saved more than CAD $30,000 annually since the upgrade. The UK's Glyndebourne Opera has altered building lighting and controls, upgraded its air handling systems, and trained staff to minimize energy consumption, with the goal of reducing carbon emissions by 70% and getting most of its power from a new wind turbine. If theatres and other entertainment venues continue to engage ecological sustainability and begin to actively monitor and manage their energy consumption, we as an industry will have all the more data upon which to base informed decisions in the future. ■

Katie Oman is a Senior Consultant with Arts Consulting Group, a leading provider of management and planning services for the cultural sector. She is a specialist in strategic facilities planning, with an emphasis on sustainable development for arts and heritage. Katie's approach combines deep technical expertise in the complexities of cultural buildings with sensitivity to the unique needs, values, and aspirations of cultural organizations. She is a LEED-accredited professional and a Certified Sustainable Building Advisor. Prior to joining ACG, Katie was a project manager with Fisher Dachs Associates, a theatre planning and design firm. She holds a BA in Architecture from Princeton University and a Master's in Public History and Cultural Heritage from Trinity College Dublin. Katie loves dogs, cooking, adaptive reuse, and Gantt charts.

SRT 2011-2012 season, shows, and personnel

Humor Abuse
Bagley Wright Theatre
Director: Erica Schmidt
Lighting design: Ben Stanton

Circle Mirror Transformation
Bagley Wright Theatre
Director: Andrea Allen
Lighting design: Andrew Smith

Sylvia
Bagley Wright Theatre
Director: R. Hamilton Wright
Lighting design: L. B. Morse

How to Write a New Book for the Bible
Bagley Wright Theatre
Director: Kent Nicholson
Lighting design: Alexander Nichols

I Am My Own Wife
Leo K. Theatre
Director: Jerry Manning
Lighting design: Robert Aguilar

Red
Bagley Wright Theatre
Director: Richard E. T. White
Lighting Design: Robert Petersen

Or,
Leo K. Theatre
Director: Allison Narver
Lighting design: L. B. Morse

Clybourne Park
Bagley Wright Theatre
Director: Braden Abraham
Lighting design: L. B. Morse