

**Light Tubes:  
A Process for Expanding WMU's Green  
Renovations.**

**By: Kegan Schildberg**

April 22, 2009

**Executive summary:**

*Light Tubes*

Kegan Schildberg

([kegan.o.schildberg@wmich.edu](mailto:kegan.o.schildberg@wmich.edu))

ENVS 4100: Appropriate Technology and Sustainability – Ecological Design: The Campus as a Living Laboratory.

Dr. Glasser

Problem: The ENVS office lacks natural light, sighted as a concern by faculty.

Opportunities:

- This project has the potential to satisfy four areas of the TALLOIRES

DECLARATION:

> Increase Awareness of Environmentally Sustainable Development

Use every opportunity to raise public, government, industry, foundation, and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future.

> Create an Institutional Culture of Sustainability

Encourage all universities to engage in education, research, policy formation, and information exchange on population, environment, and development to move toward global sustainability.

> Practice Institutional Ecology

Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations.

> Involve All Stakeholders

Encourage involvement of government, foundations, and industry in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with community and nongovernmental organizations to assist in finding solutions to environmental problems.

- Taking the same numbers we can calculate that light tubes would eliminate the ENVS office's lights 219 MTeCO<sub>2</sub> output over a 300 day period.

- Bring natural light to the ENVS Office, which has been shown in studies to improve productivity.

- Showcase WMU as a leader in sustainability research by pioneering a comparative study of light tubes from different companies, something that has yet to be done.

- Use study as a model for future WMU renovations, and garner interest in WMU and "kick off" new green renovations.

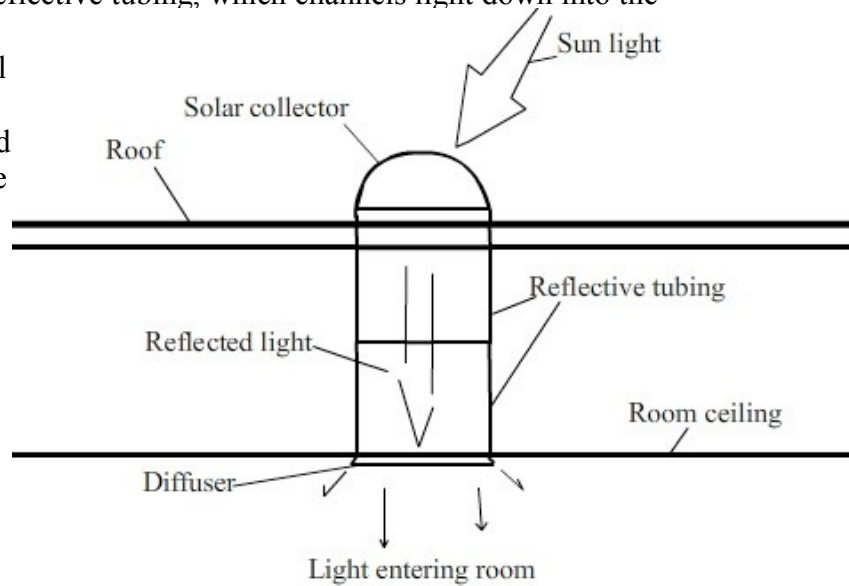
- Move WMU a step closer to achieving a "greener" campus.

What is a light tube?

Light tubes are, at their most basic, a hole in the roof of a building, with a tube sticking out. At their most complex, they are a way of allowing sun light into an otherwise window-less room that utilizes sophisticated reflective coatings, optical diffusers, and dynamic controls.

A light tube is composed of two primary components: (1) The solar collector, which is a high impact plastic dome that acts as an end cap to the tube blocking out precipitation and ultraviolet rays and

(2) A length of mirrored or reflective tubing, which channels light down into the structure. The light tube is installed by removing a small section of roof, installing the solar collector in the removed section, and then running the tubing from the solar collector through the roof to a “light fixture” or the “diffuser” in the room that is to be lit.



Concerns:

Concerns have been raised about the structural integrity of the roof (rightly so). We have however, received initial approval for the study from Director of Maintenance Services, Peter Strazdas, and a part of the study is indeed geared toward documenting installation practices and time for installation, as well as monitor roof integrity.

The Study:

The study it's self will investigate:

- Initial cost of start up and installation
- Time it takes for installation
- Requirements for structural modifications (if any)
- Materials used in the tubes themselves
- Lifecycle and associated costs
- Actual light output vs. company claims in lumens
- Durability
- Precipitation/roof leak potential
- Heat output (if any)
- Control of light output (dimmer/screen)
- Actual area light by the tube (does the light diffuse over a large area or is it concentrated) in square feet

The prospect has already gained interest within the light tube companies involved and the leading green architectural/ Real Estate Company in Grand Rapids; Bazzani Associates. It is clear that this project will not only help WMU in similar future renovations, but represents a great potential for WMU to model and evaluate green products with benefits for the region and the nation.

**Introduction:**

The basic thought behind this project is that the ENVS Common Area lacks adequate lighting; more specifically, it lacks natural light. Many people believe that a potential cost-effective solution, with wider application around campus and beyond, would be to install solar light tubes. It is my goal with this project, to test this assertion. This project would not only brighten up the ENVS Common area with potentially sustainable light during the day, but also study different light tubes from three different companies, in an attempt to discern which would be most beneficial for sustainable renovations. The intent of the research is to supplement the instillation, with the aforementioned side by side comparison of three different light tubes from three different companies.

In its initial conception, this projects intent was to be a “straight” research project, which would have called for the installation of several tubes, and the subsequent study of several criteria and the comparison of the data to other studies. Unfortunately, I could find no other side-by-side or lifecycle comparisons of the more than twenty solar light tubes currently being manufactured. Furthermore, because the installation required roof penetrations, there was and is, a concern by those responsible for roof maintenance about their performance over time.

After several meetings with my professor Dr. Glasser, the project began to shift its goals. Currently, we can view the light tubes project as an example of “Innovation Diffusion” and “Social Learning for Sustainability” (Rogers 1962, Glasser 2007, Wals 2007). The theory of *Innovation Diffusion* postulates that successful innovations address five common characteristics: *relative advantage* (what advantages do light tubes offer), *compatibility* (how can we incorporate light tubes into our current space), *complexity* (is

there a simpler way), *trialability* (how do we test and compare the tubes), and *observability* (what can we learn and observe from the light tube study) (AtKisson 1991).

### **History:**

At first glance light tubes seem to be a new innovation, but in actuality they have roots extending back to ancient Egypt. Ancient times saw light tubes as nothing more than narrow shafts, occasionally lined with reflective material to better direct the sun's rays into the structure they were lighting. The best examples of these ancient light tubes are found in tombs, bringing light into hidden chambers.

Starting in the 1850's, Paul Emil Chappuis revived the concept of light tubes by designing reflectors to send sun-light into buildings; these were in production until his company's factory was destroyed in the second world war. What we would think of as the "modern solar tube" came about in 1981, but did not become commercially available on a wide scale until 1991. Solar tubes to this day however, do not enjoy widespread use in commercial buildings or residences.

### **Methodology and Data:**

#### 1) Criteria:

When I came on-board to this project, the idea was simple. Let us install a light tube in the ENVS Common Area because it's the sustainable thing to do. Not a bad idea, however, when I actually began writing the grant for the tubes, it was made obvious that the project would need to involve research. Dr. Glasser initially suggested testing two tubes from two different companies's, eventually expanding this to three tubes from three different companies, comparing them against each other, and basing our comparisons on the following criteria:

- Initial cost of start up and installation
- Time it takes for installation
- Requirements for structural modifications (if any)
- Materials used in the tubes themselves
- Lifecycle and associated costs
- Actual light output vs. company claims in lumens
- Durability
- Precipitation/roof leak potential
- Heat output (if any)
- Control of light output (dimmer/screen)
- Actual area light by the tube (does the light diffuse over a large area or is it concentrated) in square feet

2) Company data:

After initial research, it was decided that a company called Solatube was likely the industry leader and that it should be compared with a company that it considered its top competition. Solatube representatives identified Velux as their top competitor, and after a review of data, that could be found on company websites, a third subject was identified as Huvco.

Preliminary data for the three front runners:

Company	Warranty	Light output	Leak	Heat gain
Solatube 21"	10 years, but electrical components 5 years			
Velux 22"	5, 10, & 20 years available			
Huvco 21"	Life time structural modifications			
Solatube 21"	no	500 sq ft	none claimed	nothing specific
Velux 22"	?	225 sq ft	None claimed	nothing specific
Huvco 21"	n/a	500 sq ft	None claimed	Heat gain Coefficient: 0.33

### 3) ENVIS Carbon output and light costs:

To begin to calculate how beneficial the light tubes can be, we can start by looking at them in terms of dollar savings and GHG (green house gas) emissions. A summary of calculations are as follows. There are 12 banks of light bulbs, each containing 3 bulbs each, giving a total of 36 GE Trimline F32T18 32 watt bulbs. We then can calculate that the lights produce 1152 Watts, and over 300 days we are looking at 3,456 kwh. At a rate of 8.9 cents per kwh of electricity used in Michigan, we spend \$308 over that same 300 day period. Meaning that a rough pay back period for 3 light tubes would be around 10 years, this is using conservative estimates of the energy savings supplemented by the light tubes.

To further look into the advantages of light tubes, using an average of natural gas and coal emissions factor of roughly 63.5 kg/Kwh, the ENVIS office produces roughly 219 MTeCO<sub>2</sub> over a 300 day period. The instillation of light tubes, which do not use electricity, would eliminate these carbon emissions almost completely.

#### **Best Practice:**

We appear to be treading totally new ground with this project. I have not been able to find any examples of what we are proposing to do with this project. Other schools and institutions have installed light tubes before, but no one has preformed a sided by side comparison of tubes from different companies.

#### **Discussion:**

The reasons that that this project is worth while are as follows:

1: The project saves money, roughly \$308 per year, and reduces carbon emissions by around 219 MTeCO<sub>2</sub> a year.

2: This project has the potential to satisfy four areas of the Talloires Declaration :

- **Increase Awareness of Environmentally Sustainable Development**  
Use every opportunity to raise public, government, industry, foundation, and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future.
- **Create an Institutional Culture of Sustainability**  
Encourage all universities to engage in education, research, policy formation, and information exchange on population, environment, and development to move toward global sustainability.
- **Practice Institutional Ecology**  
Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations.
- **Involve All Stakeholders**  
Encourage involvement of government, foundations, and industry in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with community and nongovernmental organizations to assist in finding solutions to environmental problems.

3: This project represents an example of innovation diffusion and social learning for sustainability, with the ultimate goal of spreading the idea of sustainable renovations for existing structures.

4: The project's location is ideal for a test of this kind. The ENVS Office common area is a long hallway like area, with no windows, it is also on the top floor of the building, and so minimal structural changes are needed.

5: The project is relatively small, so the university will not lose a large amount of money.

6: The project has received initial approval for the study from Director of Maintenance Services, Peter Strazdas, so the ground work for the project has already been laid.

7: According to research, natural light has been shown to improve the productivity and overall health of students and faculty. (Heschong Mahone Group INC., 1999, 2003).

8: The prospect has already gained interest within the light tube companies involved and the leading green architectural/ Real Estate Company in Grand Rapids; Bazzani Associates.

9: It will showcase WMU as a leader in sustainability research by pioneering a comparative study of light tubes from different companies, something that has yet to be done.

10: We have already received enough money from the Gwen Frostic Research Grant to purchase a light tube, so the project could begin this year.

This project represents a great opportunity for WMU to expand research on light tubes, not only for the benefit of this campus, but the entire region, and the nation as a whole. It is relatively low budget with the average tube running about \$600 plus the cost of installation. The benefits of this project far out weigh the relatively minimal cost of running the project, and thus this project would be a most worth while investment for WMU both for the gain of the campus internally and for the reputation of WMU regionally and nationally.

**Limitations:**

My first and greatest regret is that I didn't get started on the first draft of the Grant proposal until 4 days before it was due, not because I put it off, it was simply a matter of introduction to the project. Secondly, I regret that I was unable to gather all of the data on

the companies that we (Dr. Glasser and I) wanted. Some of the companies, and by some I mean all, of the companies except Huvco, did not give me the data that I wanted.

Thankfully, the folks at Huvco were really on top of things giving me all of the data I wanted in a timely manner.

### **Future Work:**

For future work, I would actually like to run the study and make determinations and recommendations. Though writing this proposal was interesting, it was just that, a proposal or a beginning as it gets the ball rolling so to speak. While it is interesting, it is not as interesting as actually doing the research.

Also, studying the U-factors on these light tubes would be most beneficial. The U-factor is described as:

“U-Factor; The U-factor measures how well a product prevents heat from escaping. The rate of heat loss is indicated in terms of the U-factor of a window assembly. U-factor ratings generally fall between 0.20 and 1.20. In the United States, the U-factor is usually expressed in Btu/h ft<sup>2</sup> F. The metric equivalent unit is W/m<sup>2</sup> K. The insulating value is indicated by the R-value, which is the inverse of the U-factor. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value. The U-factor is included in the energy performance rating (label) offered by the National Fenestration Rating Council (NFRC).”

From: <http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/article/102>

### **Conclusions/Recommendations:**

In summation, light tubes represent a great opportunity for WMU. No one has preformed a study like this on light tubes; their potential benefits out weigh the costs of start up. They have been scientifically proven to increase productivity, health. They also save money and CO2 emissions. In the short term we get to perform a study that no other organization or group has preformed, and brighten up a “dungeon-like” work space. In the long run, our research can help WMU in future renovations. This research can also help renovation companies and any others who want to install light tubes. The project is relatively low cost and low key; it represents minimal risks with the potential for great gains for our University, State, Nation, and potentially the entire planet.

**Special thanks to:**

Dr. Harold Glasser  
Brittainy R. Roth  
Stacey Schildberg  
Chris Caprara

**References:**

- AtKisson, Alan (1991). “The Innovation Diffusion Game”. *In Context*. No. 28 pp.58-63.
- Glasser, H. (2007). *Minding the Gap: The Role of Social Learning in Linking Our Stated Desire for a More Sustainable World to Our Everyday Actions and Policies*. Social Learning: Toward a More Sustainable World. A. E. J. Wals. Wageningen Academic Publishers, Wageningen, The Netherlands: 35-61.
- Heschong Mahone Group INC. (1999). “Daylighting in Schools: An investigation into the relationship between daylighting and human performance: Condensed Report.” California Board for Energy Efficiency.
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- Rogers, E. (1962). *Diffusion of Innovations*. New York, Free Press.

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United States Environmental Protection Agency Office of Air and Radiation. (2007). Climate change & you what you can do at the office. [Washington, D.C.], U.S. Environmental Protection Agency, Office of Air and Radiation.

[http://www.aboutlightingcontrols.org/education/papers/daylight\\_harvesting.shtml](http://www.aboutlightingcontrols.org/education/papers/daylight_harvesting.shtml)  
[http://www.veluxusa.com/solar\\_tube.htm](http://www.veluxusa.com/solar_tube.htm)  
<http://mastercraftdesignbuild.com/index.php/Energy-Saving-Ideas/Solar-Lighting-Tubes.html>  
<http://www.lowimpactliving.com/blog/2008/01/14/how-to-install-solar-tube-light/>  
<http://gardengnomeathome.blogspot.com/2009/01/solar-tube-alternative-lighting.html>  
<http://www.scienceandsociety.co.uk/results.asp?image=10422108>  
<http://www.scienceinpublic.com/freshinnovators/2005/Veronica/veronicagarciahansen.htm>  
<http://www.solatube.com/commercial/>  
<http://www.huvco.com/>  
<http://ezinearticles.com/?Passive-Solar-Lighting---A-History-of-Solar-Tubes&id=1761791>  
<http://www.ppiny.org/reports/jtf/electricprices.html>  
<http://cdiac.ornl.gov/pns/faq.html>

## **Appendices:**

### **1: Contact:**

Kegan Schildberg: [kegan.o.schildberg@wmich.edu](mailto:kegan.o.schildberg@wmich.edu)

### **2: Contact Log:**

E-mails regarding solar tubes:

>> ordered from most to least recent.

----- Original Message -----

From: Eric huffman <[erich@huvco.com](mailto:erich@huvco.com)>

Date: Monday, March 30, 2009 8:30 am

Subject: Light tubes study

Suggested retail pricing for a 21" kit with 4' of tube is around \$600. The price will vary greatly with the length of tube and other options selected.

Thanks,

Eric G. Huffman  
HUVCO, Daylighting Solutions  
Post Office Box Three

Rohrersville, Maryland 21779  
301-432-0678  
800-832-6116  
Fax: 301-432-7185  
www.huvco.com

-----Original Message-----

From: Kegan O Schildberg [kegan.o.schildberg@wmich.edu]  
Sent: Friday, March 27, 2009 8:49 PM  
To: erich@huvco.com  
Subject: Re: RE: RE: Light tubes study

4-5 feet, but that is just a guess, again I have yet to meet with building management. I also checked with my professor, and it is absolutely o.k. for you to use any and all data collected from this study.

----- Original Message -----

From: Eric huffman <erich@huvco.com>  
Date: Friday, March 27, 2009 11:04 am  
Subject: RE: RE: Light tubes study

How long will the tube need to be?  
To go from the roof to the ceiling?

Eric G. Huffman  
HUVCO, Daylighting Solutions  
Post Office Box Three  
Rohrersville, Maryland 21779  
301-432-0678  
800-832-6116  
Fax: 301-432-7185  
ww.huvco.com

-----Original Message-----

From: Kegan O Schildberg [kegan.o.schildberg@wmich.edu]  
Sent: Wednesday, March 25, 2009 10:51 PM  
To: erich@huvco.com  
Subject: Re: RE: Light tubes study

A question regarding cost:

Thanks again for all of the information you sent, I am sorry that I neglected to add the size that we were looking at. We are looking at the 21 inch light tube. I can't give you any specifics regarding the roof, other than it is a flat roof, as I have not met with building maintenance. I was wondering given the little information that I have given about the roof if you could give a rough estimate of the cost. It can be really rough, I just need a ballpark price to work with.

thanks,

-Kegan

----- Original Message -----

From: Eric huffman <erich@huvco.com>  
Date: Monday, March 23, 2009 8:47 am  
Subject: RE: Light tubes study

That sounds great.

In response to your questions:

1. The cost varies by size and length. What size do you want quoted?

See attached order form.

2. Two hours or less for typical installation 3. The system works off of ambient light. However as the sun moves through the horizon the amount of light entering the tube dramatically effects the output.

4. See attached testing data from France. This was done LONG ago, and we have changed our design and materials since then.

5. Both Energy Star and Building Code tests have been completed.

6. U Value is .46 (see NFRC label attached)

I hope this helps answer your questions.

Now a few for you:

1. Will you inform us what other brands you are testing?

2. Will we be allowed to use your test results in publications and advertising?

3. Will you consider our other daylighting products for some of your buildings? The tubular skylight is not always the best way to daylight a space. Especially large open spaces. Our High Performance

Daylighting System (HPDS) is usually a better choice for many commercial applications.

This larger system allows for much more light per unit and therefore fewer penetrations in the roof and better diffusion of the light. See [www.huvco.com](http://www.huvco.com) for more details.

We look forward to serving your daylighting needs.

Sincerely,  
Eric

Eric G. Huffman  
HUVCO, Daylighting Solutions  
Post Office Box Three  
Rohrersville, Maryland 21779  
301-432-0678  
800-832-6116  
Fax: 301-432-7185  
[www.huvco.com](http://www.huvco.com)

-----Original Message-----

From: Kegan O Schildberg [kegan.o.schildberg@wmich.edu]  
Sent: Sunday, March 22, 2009 2:45 PM  
To: erich@huvco.com  
Subject: Light tubes study

Thanks again for your interest in this project. I have been working with the Professor who is the head of the President's university-wide sustainability committee and we have been in contact with

Western Michigan University planning and building. We are looking into doing a side by side insitu study of 3 different light tubes from 3different companies.

This study will help WMU decide on light tubes for future renovations and retrofits of campus building.

To help us with the study we would like some specific information about your light tubes.

-What is the cost of the light tube it's self?

-What is a realistic instillation time for a professional?

-How dose the square footage of lighting differ during different times of the year?

-Do you have data for the light out put in lumens?

-What is the durability of your product? Have you run any independent tests to determine this? If yes could you share the test data with us?

-What are the standards for heat gain with your product?

Any answers that you could offer to these questions would be

most appreciated. If you have any questions for me or if I have been

unclear about something please e-mail me at: kegan.o.schildberg@wmich.edu.

Thanks again for your time and help.

-Kegan

Thanks I will, the study is in the planning stages at the moment, when I get a concrete list of what I need will let you know. Thanks for your interest.

-Kegan

----- Original Message -----

From: Mark Hayes <mhayes@sun-tek.com>

Date: Tuesday, March 17, 2009 10:03 am

Subject: RE: Study

Kegan,

Let me know what you need for your research.

Best regards,

Mr. Mark Hayes

Sun-Tek Skylights

10303 General Drive

Orlando, Florida 32824

ph: 407-859-2117

fx: 407-859-6607

-----Original Message-----

From: Glen Sincic [gsincic@sun-tek.com]

Sent: Wednesday, March 11, 2009 1:52 PM

To: mhayes@sun-tek.com

Subject: FW: Study

-----Original Message-----

From: Kim Cranston [customerservice@sun-tek.com]

Sent: Wednesday, March 11, 2009 9:40 AM

To: gsincic@sun-tek.com

Subject: FW: Study

-----Original Message-----

From: Kegan O Schildberg [kegan.o.schildberg@wmich.edu]

Sent: Tuesday, March 10, 2009 10:52 PM

To: customerservice@sun-tek.com  
Subject: Study

Hello, my name is Kegan Schildberg. I am a student at Western Michigan University, I am an environmental science major and I am currently looking into performing a side by side comparison of light tubes from several leading companies. I have identified your company as a leader in the field of light tubes and I am considering your product for this research. If your company is interested in this study please let me know via e-mail (kegan.o.schildberg@wmich.edu), your interest and cooperation would be most helpful.

Of course, right now the study is in the planing stages, and when we get more concrete outline of the details I will let you know. Thanks for responding, and thanks for your interest.

----- Original Message -----

From: Eric huffman <erich@huvco.com>  
Date: Wednesday, March 11, 2009 10:29 am  
Subject: RE: HUVCO - Website Contact Form Submit

We would probably be interested.  
We would need to know more details about the study and how it will be performed and to what standards.

Thanks,

Eric G. Huffman  
HUVCO, Daylighting Solutions  
Post Office Box Three  
Rohrersville, Maryland 21779  
301-432-0678  
800-832-6116  
Fax: 301-432-7185  
www.huvco.com

At the moment we are looking into testing;  
Heat output,  
Lifecycle,  
Durability,  
construction materials & methods,  
and instillation and life cycle costs.

The test criteria is still evolving and when we have the final criteria worked out I would be more than happy to send you a copy. Thanks for responding and thanks for your interest.

-Kegan

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**Kegan,**

**Thank you for the interest in our energy efficient solar lighting tubes and I would like to know more about how you plan to test a tubular skylight and what it is you will be looking to determine.**

**All of our units have been tested structurally for large missile impacts such as hail and for high velocity wind loads and for light production as well as SHGC and U-Value and R-value in controled**

laboratory tests, so you can see why we would be interested in how our system would be tested in your situation.

Please let me know how I may help you.

Best Regards,

Don/Sun-Dome  
[www.sun-dome.Net](http://www.sun-dome.Net)  
[www.sun-dome.com](http://www.sun-dome.com)  
800-596-8414

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2) Various e-mails within the "WMU system":

I have used Velux's traditional, operable skylights, but I don't have any experience with their tubular product. They're a solid company, and I was very happy with their traditional skylights.

-Jim

**From:** harold.glasser@wmich.edu [mailto:harold.glasser@wmich.edu]  
**Sent:** Sunday, February 22, 2009 2:24 PM  
**To:** Jim Nicolow  
**Cc:** Kegan Schildberg; Brittainy Roth; Thomas Keranen  
**Subject:** Re: Solar light tubes

Dear Jim,

THANKS! This info is tremendously helpful.

I spoke to a product manager from Solatube on Friday and she suggested several of the same manufacturers too!

She said that they view their biggest competitor these days as VELUX:

[http://www.veluxusa.com/solar\\_tube.htm](http://www.veluxusa.com/solar_tube.htm)

Do you know anything about them?

I also saw VP Rinker on Fri and he mentioned that he might be interested in consulting with you re. planning for the Sangren renovation. Give me a call, if you want to chat sometime soon.

Cheers,

Harold

On Feb 20, 2009, at 10:45 AM, Jim Nicolow wrote:

FYI.

-----Original Message-----

From: Jim Nicolow  
Sent: Wednesday, February 18, 2009 12:12 PM  
To: Thomas Eugene Keranen  
Subject: RE: Solar light tubes

Solatube is the best-known manufacturer, and the only one with which we have experience. They've added 'damper' controls that let you turn off the natural light when/if you need to darken the room, and they have larger commercial systems as well as smaller residential systems:

<http://www.solatube.com/>

I looked on the Building Green site ([www.buildinggreen.com](http://www.buildinggreen.com)), and they listed several additional tubular skylight manufacturers that may be of interest:

<http://www.sun-dome.net/>  
<http://www.huvco.com/>  
<http://www.odl.com/>  
<http://www.sunscope.com/>  
<http://www.sunpipe.com/>  
<http://www.sun-tek.com/>  
<http://www.tru-lite.com/>  
<http://www.tubular-skylight.com/>

-Jim

Jim Nicolow, AIA, LEED AP  
Direct Phone 404-253-1458 | Direct Fax 404-253-1358  
LORD, AECK & SARGENT ARCHITECTURE  
Responsive Design · Technological Expertise · Exceptional Service  
Please visit our new website | [www.lordaecksargent.com](http://www.lordaecksargent.com)  
Think GREEN before you print. □

-----Original Message-----

From: Thomas Eugene Keranen [mailto:[thomas.e.keranen@wmich.edu](mailto:thomas.e.keranen@wmich.edu)]  
Sent: Thursday, February 12, 2009 1:05 PM  
To: Jim Nicolow  
Subject: Solar light tubes

Dear Jim,

We are students in Dr. Glasser's Appropriate Technologies and Sustainability course. We are redoing our environmental studies office area and are looking into running a pilot with comparing different light tubes. If you could please send us a list of light tubes that you believe are especially promising and ones to avoid, we would greatly appreciate it.

Thank you for your time.

Tom Keranen  
Thomas.E.Keranen@wmich.edu

Brittainy Roth  
[Brittainy.R.Roth@wmich.edu](mailto:Brittainy.R.Roth@wmich.edu)

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Dr. Glasser,

I think you covered all aspects well.

Looking forward to your findings

Thanks

Anand

>>> Harold Glasser <harold.glasser@wmich.edu> 2/24/2009 11:36 AM

>>>

Dear Pete and Anand,

Kegan Schildberg and I are moving forward on a study to explore the relative costs and benefits of the 21" light tube options that are available commercially.

We will be looking at manufacturers claims, installation reports,

private studies, etc. to get a handle on first cost, warranty, installation time, requirements for structural modifications (if any), materials and construction of light tubes, light output, durability

(including flashing/leak potential & reports), ability to control

light output, heat production, etc.

Do you two have any specific or additional criteria that are crucial to you that you want us to explore/evaluate?

All the best,

Harold and Kegan

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Kegan,

Here is the e-mail that I got from Jim about the light tubes. I hope that it helps you out.

~Tom

Solatube is the best-known manufacturer, and the only one with which we have experience. They've added 'damper' controls that let you turn off the natural light when/if you need to darken the room, and they have larger commercial systems as well as smaller residential systems:

<http://www.solatube.com/>

I looked on the Building Green site ([www.buildinggreen.com](http://www.buildinggreen.com)), and they listed several additional tubular skylight manufacturers that may be of interest:

<http://www.sun-dome.net/>

<http://www.huvco.com/>

<http://www.odl.com/>

<http://www.sunscope.com/>

<http://www.sunpipe.com/>

<http://www.sun-tek.com/>

<http://www.tru-lite.com/>

<http://www.tubular-skylight.com/>

-Jim

---

I'm sharing your email addresses so you can facilitate collaboration on the light tube grant proposal.

Kegan offered to be the lead person to coordinate the ENV5 Grant proposal—they are due next Fri.

My suggestion is to:

1. Research and find two of the "most promising" light tube designs to test in situ—in ENVs. I suggest identifying an area—perhaps the proposed kitchen area or common area where you might be able to compare the light tubes side by side.
2. The basic idea would be to get baseline data on the costs, GHG, efficacy of the existing lights and then look at the theoretical and actual changes with the light tubes. In addition we would want to compare life-cycle costs of the options and also address the potential impacts and costs associated with roof penetrations, etc.

Let's meet on Monday or Tues. if possible to check in and see where you are.

Cheers,

Dr. G

Begin forwarded message:

**From:** Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)>

**Date:** February 9, 2009 1:23:46 PM GMT-05:00

**To:** Anand Sankey <[anand.sankey@wmich.edu](mailto:anand.sankey@wmich.edu)>

**Subject: Re: Light Tube question**

Dear Anand,

Thanks for your openness.

I'll pass along your feedback and see how serious they are. If they want to pursue it, I'll be in touch!  
Thanks!

Cheers,

Harold

On Feb 9, 2009, at 12:41 PM, Anand Sankey wrote:

Harold,

Have them create a scope of work - I would be willing to sit down and hear their presentation with you.

Consider installation, cost vs savings, life expectancy, usage in the area, benefits, .....

the usual

Anand

Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)> 2/8/2009 3:08 PM >>>

Dear Anand,

Thanks for your continued vision and open-mindedness. Let me know if there is anything we can do to facilitate the conversation on the

light tubes. I now have a few very competent students working on the ENV5 "rehab" project and I could assign them the responsibility of

putting together a brief on light tubes. Do you have time to sit down—

or email me—a set of questions that you would like them to address.

Improving the lighting in the space (while reducing energy use) has appeared to rise to the top of their concerns.

Thanks for the update on the dorm project. I look forward to meeting

with you after the PUSC meeting on Thurs. to discuss further. Confidentially, I'd like to not involve Casey—or severely limit

her  
role—in this project. She needs to follow-through and produce on  
some  
others... and between you and me I am having some concerns about  
her  
delivering. Thanks for keeping this between us. That said, I can  
  
think of some other students that could, I think, help to get the  
job  
done... I just need to get a better handle on the details what you  
  
want to happen with this pilot.

Cheers,

Harold

On Feb 8, 2009, at 9:05 AM, Anand Sankey wrote:

Harold,

Let's continue the discussion - certainly something I would like  
to  
explore.

As for the dorm project - I am waiting for Doug Carney - Res  
Life  
to get back to me on his team - sounds like I have your support  
and  
a few students, Casey has responded and is waiting for the kick  
off  
meeting.

Doug was on AL last week - I will bump him again and I would  
like  
to have a kick off meeting next week.....

After the PUSC meeting would be great - I could even buy you a  
drink if you have time

Thanks

Anand

Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)> 2/5/2009 4:36 PM

Dear Anand,

Thanks for the thoughtful reply.

I certainly appreciate the point about intentional roof  
penetrations—  
but on the positive side this sort of intentional roof  
penetration  
is  
probably much better than most unintentional roof penetrations?

Please see some additional comments below:

On Feb 4, 2009, at 8:49 PM, Anand Sankey wrote:

Harold,

Intentional roof penetrations is really something that is not viewed with great enthusiasm. Especially when we have spent nearly 10 years and \$\$\$ fixing leaks on campus....:)

One has to assume that if done correctly will not cause any negative consequences.  
And, hopefully, some positive ones!

With that said the benefits, life cycle cost, energy savings, cost of installation and product should be calculated, I also understand the human behavior benefit that cannot be measured by having daylight.  
Would you like us to do this? If there is a possibility that we could include the human behavioral aspects (potential benefits) into our

analysis and if there is a real possibility that if things look "good" (what would "good" mean exactly?) we would be given approval

and perhaps some help with funding a trial, I'd be honored to work

with you to develop an acceptable protocol and do the analysis.

What do you think?

On another matter, do you want to meet again soon to discuss the Human Behavior Energy Conservation in a Dorm project? Should we set something up at the PUSC meeting next Thurs. or before?

Cheers,

Harold

I would be interested in looking at theoretical analysis before moving into the testing phase.

Thanks

Anand

Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)> 2/4/2009 5:06 PM

Dear Anand,

Brittainy and Thomas from my 410 class are exploring strategies to

improve the ENVS suite. One of the big issues that they are trying to address is lighting. They have been researching light tubes and are wondering if there has been any interest in testing them out on campus? Do you think the powers at be would allow roof penetrations to test out some light tubes. We wanted to ask you first to get your thoughts on the matter.

Thanks!

Cheers,

Harold

Begin forwarded message:

**From:** Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)>

**Date:** February 8, 2009 3:08:16 PM GMT-05:00

**To:** Anand Sankey <[Anand.Sankey@wmich.edu](mailto:Anand.Sankey@wmich.edu)>

**Subject: Re: Light Tube question**

Dear Anand,

Thanks for your continued vision and open-mindedness. Let me know if there is anything we can do to facilitate the conversation on the light tubes. I now have a few very competent students working on the ENVS "rehab" project and I could assign them the responsibility of putting together a brief on light tubes. Do you have time to sit down—or email me—a set of questions that you would like them to address. Improving the lighting in the space (while reducing energy use) has appeared to rise to the top of their concerns.

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Harold

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Doug was on AL last week - I will bump him again and I would like to have a kick off meeting next week.....

After the PUSC meeting would be great - I could even buy you a drink if you have time

Thanks

Anand

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Cheers,

Harold

Begin forwarded message:

**From:** Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)>  
**Date:** February 5, 2009 4:36:34 PM GMT-05:00  
**To:** Anand Sankey <[Anand.Sankey@wmich.edu](mailto:Anand.Sankey@wmich.edu)>  
**Subject: Re: Light Tube question**

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Cheers,

Harold

Begin forwarded message:

**From:** Harold Glasser <[harold.glasser@wmich.edu](mailto:harold.glasser@wmich.edu)>

**Date:** February 4, 2009 5:06:10 PM GMT-05:00

**To:** Anand Sankey <[anand.sankey@wmich.edu](mailto:anand.sankey@wmich.edu)>

**Cc:** Brittainy Roth <[brittainy.r.roth@wmich.edu](mailto:brittainy.r.roth@wmich.edu)>, Thomas Keranen <[thomas.e.keranen@wmich.edu](mailto:thomas.e.keranen@wmich.edu)>

**Subject: Light Tube question**

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Thanks!

Cheers,

Harold

**Research grant proposal:**

Names: Kegan O. Schildberg

Brittainy R. Roth

WIN: 176320938

196097332

E-mail: [kegan.o.schildberg@wmich.edu](mailto:kegan.o.schildberg@wmich.edu)

[brittainy.r.roth@wmich.edu](mailto:brittainy.r.roth@wmich.edu)

Majors: Environmental Studies, Environmental assessment and management

Environmental Studies, Political Science

Project Category: Demonstration/education/outreach

Project mentor: Dr. Harold Glasser

**THE ISSUE:**

A top concern cited by both students and faculty in the ENVS Common Area is the lack of adequate lighting, particularly natural light (as an example, a survey sent via email on February 11, 2009 found six out of twelve faculty and staff to reference lighting as a problem). A potential cost-effective solution with wider application on campus and beyond would be to install solar light tubes. There are unfortunately no sophisticated side-by-side or lifecycle comparisons of the more than twenty solar light tubes currently being manufactured. Furthermore, because the installation of the solar light tubes requires roof penetrations, there is a significant perceived concern by those responsible for roof maintenance about their performance over time. From this perspective, light tubes represent an example of innovation diffusion and social learning for sustainability (Rogers 1962, Glasser 2007, Wals 2007). While they existed in a simplified form in ancient Egypt, they are—in their modern state—new and untested for most people. The theory of innovation diffusion postulates that successful innovations address five common characteristics: *relative advantage*, *compatibility*, *complexity*, *trialability*, and *observability* (AtKisson 1991). From the standpoint of social learning for sustainability modeling and testing more sustainable practices—using the campus as a living, learning laboratory addresses all of the elements of innovation diffusion theory. We will use the lens of innovation diffusion to help explore the feasibility, efficacy, and cost-effectiveness of light tubes. To begin to shed light on these questions—we propose to install and evaluate two-three light tubes from leading companies.

## **PROJECT DESCRIPTION:**

**Background on light tubes:** Light tubes are, at their most basic, a hole in the roof of a building, with a tube sticking out. At their most complex, they are a way of allowing sun light into an otherwise window-less room that utilizes sophisticated reflective coatings, optical diffusers, and dynamic controls. The reasons for employing light tubes are simple; they have the potential to reduce energy consumption during the day, reduce cooling loads at times of peak demands, reduce the green house gas (GHG) emissions of a building, brighten a dreary work space, and improve worker productivity.

A light tube is composed of two primary components: (1) The solar collector, which is a high impact plastic dome that acts as an end cap to the tube blocking out precipitation and ultraviolet rays and (2) A length of mirrored or reflective tubing, which channels light down into the structure. The light tube is installed by removing a small section of roof, installing the solar collector in the removed section, and then running the tubing from the solar collector through the roof to a “light fixture” in the room that is to be lit.

**Objectives:** The objectives of this project are three-fold: (1) bring sunlight into the ENV5 Common Area, which has been shown to improve the productivity of staff and students (Heschong Mahone Group INC., 1999, 2003); (2) explore and test the theory of innovation diffusion through a practical example (Rogers, 1962, Atkisson 1991); and (3) research the claims of the companies by performing side-by-side comparisons of at least two leading product designs, including an evaluation of the following criteria:

- Initial cost of start up and installation
- Time it takes for installation
- Requirements for structural modifications (if any)
- Materials used in the tubes themselves
- Lifecycle and associated costs
- Actual light output vs. company claims in lumens
- Durability
- Precipitation/roof leak potential
- Heat output (if any)
- Control of light output (dimmer/screen)
- Actual area light by the tube (does the light diffuse over a large area or is it concentrated) in square feet

We hope to research three 21-inch light tubes from three different companies. Based on our preliminary research (including conversations with regional green architects), the leading contenders are: Solatube, Velux, and Huvco. These companies claim to support sustainable design, have high lumen light output, and are EPA Energy Star rated. We have received initial approval for the study from Director of Maintenance Services, Peter Strazdas. Our plan is to work with maintenance services to develop an installation plan and have both units installed by the end of the summer. We intend to gather our initial data during the fall.

A cost-benefit analysis will be conducted from the data collected on the light tubes to determine if they are beneficial or a worthwhile investment in terms of energy savings, GHG emissions, and their affect on productivity on staff and students—relative to the existing fluorescent lighting (baseline).

**SIGNIFICANCE:**

The results of this study will determine the effectiveness, appeal, and the costs and benefits of installing solar light tubes. Its subsequent research could potentially yield useful information for future remodeling projects at WMU, and for groups outside of WMU, such as “green” building companies, who would be able to review the components of our study and decide which light tube best fits the parameters of their projects.

**COST:**

From the preliminary research, the light tube and installation for one costs around \$500, so this grant would cover the cost of one tube. We hope to get the physical plant, College of Arts and Sciences, or a company to donate/purchase the other.

Thank you for your consideration.

**References**

AtKisson, Alan (1991). “The Innovation Diffusion Game”. *In Context*. No. 28 pp.58-63.

Glasser, H. (2007). Minding the Gap: The Role of Social Learning in Linking Our Stated Desire for a More Sustainable World to Our Everyday Actions and Policies. *Social Learning: Toward a More Sustainable World*. A. E. J. Wals. Wageningen Academic Publishers, Wageningen, The Netherlands: 35-61.

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Heschong Mahone Group, INC. for the California energy commission. (2003). “Windows and Offices: A study of office worker performance and the indoor environment.”

Rogers, E. (1962). *Diffusion of Innovations*. New York, Free Press.

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United States Environmental Protection Agency Office of Air and Radiation. (2007). *Climate change & you what you can do at the office*. [Washington, D.C.], U.S. Environmental Protection Agency, Office of Air and Radiation.

[http://www.aboutlightingcontrols.org/education/papers/daylight\\_harvesting.shtml](http://www.aboutlightingcontrols.org/education/papers/daylight_harvesting.shtml)

[http://www.veluxusa.com/solar\\_tube.htm](http://www.veluxusa.com/solar_tube.htm)

<http://mastercraftdesignbuild.com/index.php/Energy-Saving-Ideas/Solar-Lighting-Tubes.html>

<http://www.lowimpactliving.com/blog/2008/01/14/how-to-install-solar-tube-light/>

<http://gardengnomeathome.blogspot.com/2009/01/solar-tube-alternative-lighting.html>

<http://www.scienceandsociety.co.uk/results.asp?image=10422108>

<http://www.scienceinpublic.com/freshinnovators/2005/Veronica/veronicagarciahansen.htm>

<http://www.solatube.com/commercial/>

<http://www.huvco.com/>

<http://ezinearticles.com/?Passive-Solar-Lighting---A-History-of-Solar-Tubes&id=1761791>