4 Dec 07

Undergraduate Research Proposal
'Sem. II Lighting Efficiency'
Tony Enslow

Abstract:
The primary goal of my proposed project is to decrease energy use in TESC's Seminar II buildings, with decreased artificial light pollution and increased campus security being collateral effects. A potential solution to achieve this goal involves the integration of photocell breaker/motion sensor switches in conjunction with the existing lighting infrastructure. To achieve and determine the feasibility, impacts and costs of this goal, an accurate estimation of night-time traffic is very necessary to establish night-time occupancy, providing the data necessary to make a sound decision on lighting policy. It is also in the interest of my proposal to address the issue of photo pollution, being the presence of excess, and/or obtrusive, artificial light o campus. Exposure to photo pollution has the capability of disrupting ecosystems, obscuring stars, wasting energy and cause adverse health effects to humans.

Research Problems/Questions:

1. Claims of energy inefficiency in TESC's Seminar II buildings raise important concerns. Regardless of occupancy, outdoor lights are timed to flood both the elevated and ground level walkways with wasteful light pollution. How can energy efficiency be improved?
2. Due to the nature of current lighting infrastructure, considerable amounts of photo pollution are being released. What can be done to minimize photo pollution output?
3. Increased counts vandalism and sexual assault on TESC campus have increased the demand for security and crime prevention. Is a solution addressing all three of these problems available and cost effective?

Primary Hypothesis:

1. Photocell breakers in conjunction with photo-electric motion sensor integration with the existing lighting infrastructure will provide more than adequate night time lighting to wanting occupants
2. Decrease energy use and associated costs while eliminating unnecessary ambient light pollution
3. Serve as sentry for motion; good and bad.

Alternative Hypothesis:

1. Light pollution is a problem as is energy efficiency; photo/motion sensors use energy themselves
2. Nesting and/or nocturnal wildlife has a high potential for setting off such devices, turning lights on and wasting energy
3. TESC police maybe overwhelmed due to college expansion, more officers are needed not light switches.

Null Hypothesis:

1. Night time occupancy requires lighting therefore lights need to be on and therefore no electricity is being wasted.
2. Local ecology that would be affected by light pollution is long gone for more reasons than just light at night (i.e. a college is where the animals home used to be) so there is no point worrying about them
3. When comparing TESC and surrounding areas to national crime rates, the need for additional security is unnecessary and wasteful.

Literature Review:

As concern for environmental and human health increases with energy policy issues, many groups are taking notice and initiating progressive action to solve these and associated problems. The Dark Sky association and The Department of Energy are particularly invested groups, funding research and lobbying legislation in the attempt to increase electricity efficiency and benefits associated with said actions.

Strategies/Activities:

1. Measure the night time human traffic of TESC's Seminar II buildings to determine whether or not it is necessary for all outdoor lighting to remain on throughout the night. By randomly installing Infra-Red or photo-electric people counters in and around the Seminar II vicinity, I hope to determine the rate and duration of night-time occupancy in order to test my hypothesis that *the integration of photocell breaker/motion sensor switches in conjunction with the existing lighting infrastructure will efficiently provide adequate night-time lighting while increasing campus security and decrease artificial light pollution.* To achieve the most accurate results, more than one IR sensor and converter would me preferable, but due to the high costs of such equipment, his may not be an option.
2. Research the effects of artificial light pollution and determine if TESC policy change is necessary by taking night time artificial light measurements around campus.
3. Research correlations between different lighting systems/night light conditions and crime deterrence.

Project Preparation (week 11):

I have received full funding for occupancy sensors from TESC's Clean Energy Committee; for week 11, I intend on putting that grant money to good use. I have already made contact with a sales representative for an occupancy sensing outfitter, Sensource, and have a price estimate for the required equipment. I plan on searching for the best product for the least amount of money in the weeks to come and start collecting data as soon as possible.

Annotated Bibliography

Energy efficiency: Super savers: Meters to manage the future
Declan Butler (8 February 2007)
Nature **445**, 586-588 doi:10.1038/445586a; Published online 7 February 2007

This article proposes an energy revolution, which starts with the electricity meter. The premise resides in the fact that if utility companies don't know how their energy is being used and exactly when (according to the article they don't) there is no way they could possible mitigate consumption. Real-time, electric energy meters are 'the stepping stone' for the conservation revolution; the data these meters would present could help restructure the power grid's architecture and provide peak power efficiency.

Declan Butler, author of this article, is a senior reporter for *Nature*, gives him a bit of instant credibility. In his article Butler only briefly addresses consumer efficency, mostly turning most of his argument toward utility in effiencys. My logic goes like this: if less energy is used (consumer) less energy needs to be provided (utility company); if Butler recognizes the potential consumer conservation could provide in compilation with his utility concerns, he could have a pretty strong argument.

Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies
S. Pacala and R. Socolow (13 August 2004)
Science **305** (5686), 968. [DOI: 10.1126/science.1100103]

The concept that, with present technologies, carbon emissions can be levels within the next half-century, and drop by mid-century using any seven of the fifteen proposed methods of carbon reduction (each method would theoretically reduce carbon emissions by one billion tons of carbon annually.

This article is sited by virtually every resource looking to solve our carbon crises; because most of the proposed methods include current, or near current technologies, significant strength is given to the feasibility of this highly popularized proposal.

Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet
Martin I. Hoffert, Ken Caldeira, Gregory Benford, David R. Criswell, Christopher Green, Howard Herzog, Atul K. Jain, Haroon S. Kheshgi, Klaus S. Lackner, John S. Lewis, H. Douglas Lightfoot, Wallace Manheimer, John C. Mankins, Michael E. Mauel, L. John Perkins, Michael E. Schlesinger, Tyler Volk, and Tom M. L. Wigley (1 November 2002)
Science **298** (5595), 981. [DOI: 10.1126/science.1072357]

This article summarizes the potential for energy conservation in the realm of increasing power generation efficiency. All major, contemporary and near future, means of energy generation are mentioned and the potential for their efficiency improvements are noted. The only section of this article that does not directly pertain to electricity generation deals with

Geo-engeneering, and is more focused on the reversing of the greenhouse effect, given other options fall short.

This article includes many numbers and statistics, which are very frequently sited, which gives me comfort in the reliability of these numbers, I can look them up myself if I choose. The concluding note from the author's states that the portfolio they have provided gives many solutions to a vast problem- many ideas will be attempted, and many will fail but compromises must be made in order to achieve the collective goal.

What does utility-subsidized energy efficiency really cost?
Soskow & Marron (16 Apr. 1992)
Science, **260** (281-282)

Beginning with an optimistic summary and graph of energy efficiency and associated negative net costs to society and undeniable environmental benefits, this policy forum policy article continues by scrutinizing the optimistic data presented earlier. The main argument states the difference between technical potential (TP) and their studies actual cost of utility-subsidized efficiency programs is dramatically different, actual program cost estimates (based on TP) are 30-500% higher than predicted. These discrepancies are attributed to TP reports not taking, or underestimating, costs associated with administration/overhead/implementation/advertisement of such programs.

Since the main author, P.L. Sokow, is a professor at MIT as well as the director of the MIT economics program and director of the MIT center for energy and environmental policy research his credentials are outstanding, and if efficiency projections made by the data he opposes only takes technical potential into account, I see no reason why actual costs are higher. Sokow's conclusion to policy makers seems less than desirable, not much of a call to action, and some data interpretation may be argued not to mention there was no data represented that was easily accessed for securitization.

The evolution of the ENERGY STAR_ energy performance indicator for benchmarking industrial plant
Boyd, G (24 Jan 2007)
Manufacturing energy-use, J Clean Prod (2007),doi:10.1016/j.jclepro.2007.02.024

This article summarizes what exactly the ENERGY STAR logo means and its 15 year history, with a specific emphasis on consumer, but industrial potential for efficiency. Included is an actual ENERGY STAR 'report card' of an automobile manufacturer in Illinois. Energy performance indicators, an innovation of the DOE's ENERGY STAR program, is beginning to show an important role in manufacturing competition; i.e.(lower greenhouse emissions, reduced energy bills and more product for the same or less energy).

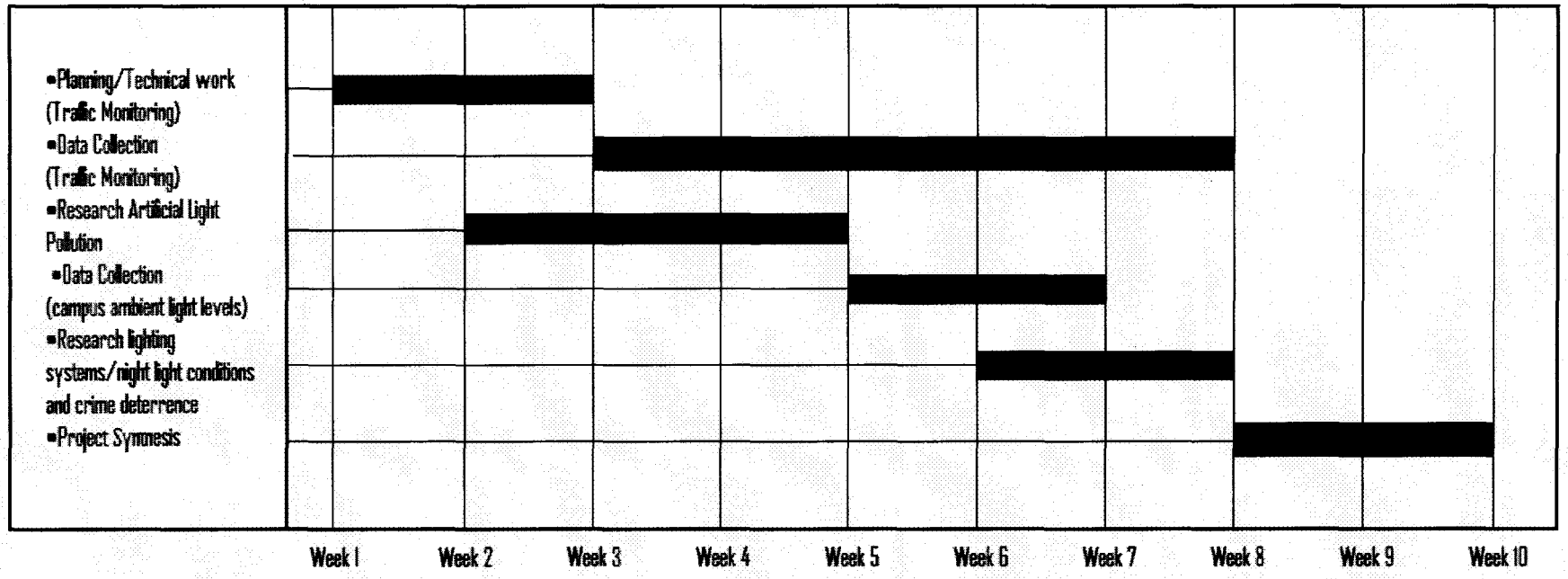
I found this article very insightful, case studies are displayed in a very self explanatory manner, the reading was a bit dry, but its informative nature and 'hard to fake' history and motivation of the EPA's ENERGY STAR program made me feel comfortable with the facts.

Proposed Project Budget

IR Sensor (PC-PIR15)	351.75
Converter (PC-P2P485)	236.25
Sensor Server (PC-SSRX485)	729.75
Data Software (SFTW-SMGR Basic)	99.75
TOTAL (occupancy sensing equipment)	**1417.5**

(includes building materials and less accurate data collection equipment)

*Prices include approx. tax/shipping charges


•Planning/Technical work
(Traffic Monitoring)
•Data Collection
(Traffic Monitoring)
•Research Artificial Light
Pollution
•Data Collection
(campus ambient light levels)
•Research lighting
systems/night light conditions
and crime deterrence
•Project Synnesis
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10