Ideas to Reduce NIST Energy Consumption and Peak Demand Charges

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The following energy saving ideas would result in considerable energy/peak demand savings at NIST's Gaithersburg campus. ***It is estimated that implementation of the following suggestions could result in a savings of one to two million dollars per year and could be implemented without major renovations to the existing buildings.*** Hopefully these ideas are already under consideration as part of NIST Administration's efforts to reduce energy costs. These ideas focus on reducing the buildings' electrical and thermal loads and not on increasing efficiencies associated with the central plant equipment. NIST has expended a great deal of effort and funds during the last decade enhancing the central plant equipment, but appears to have done little to reduce electrical loads within the buildings or improve the thermal effectiveness of the building envelopes. The energy savings ideas are:

- ***Energy Education*** – NIST employees need to be made aware of energy costs, the relationship between energy costs and time of use, and demand charges.
- ***Energy Accountability*** – The energy consumption of each building should be noted and incentives put into place to reduce energy consumption.
- ***Fenestration Unit Replacement*** – The single-pane glass windows used throughout the original NIST structures should be replaced with high performance double-pane units.
- ***Loading Dock Areas*** – Steps should be taken to reduce the loss of conditioned air to the outdoors.
- ***Proximity Light Sensors*** – Proximity light sensors should be installed in offices to ensure that lights are turned off when the office is vacant.
- ***Lighting*** – All lighting fixtures should be upgraded from T-12 to T-8 bulbs with electronic ballasts.
- ***Computers and Associated Printers*** – Computers and related equipment should be turned off during non-working hours. Data backups should occur during periods of inactivity during normal business hours.
- ***Energy Savings Model Office*** – An office or group of offices should be retrofitted to demonstrate potential energy savings.

Energy Education - By and large, the NIST community is unaware of the enormous costs associated with energy and the relationship between energy cost and time of use. Perhaps even more important is the lack of knowledge within the NIST community concerning peak demand charges and the manner in which they are computed. During the summer months a kWh of energy consumed between 12 noon and 8:00 P.M. costs approximately 90% more than a kWh of electricity used between midnight and 8:00 A.M, Attachment A.

In addition to energy charges, there are demand charges that can have a profound impact on NIST's electric bill. Demand charges are based upon the highest power demand that NIST imposes on the electric utility's generating, transmission, and distribution facilities. Peak demand charges are rarely, if ever, included on residential electric bills and thus the majority of NIST personnel are not familiar with the concept of demand charges. Peak demand charges represent a significant portion of NIST's total electric costs and may provide the greatest saving opportunity. For example, between April 4, 2002 and August 2, 2002, bill peak demand charges represent 20 percent ($391,000 of the $1,990,000) of the total electric utility bill.

There are two demand charges associated with NIST's electric rate structure. The maximum demand charge is in effect throughout the year and amounts to $4.07 per kW of power. This charge is levied each month and is based on the maximum power that NIST uses during any 30 minutes of the month. During the summer billing months (June-October) a second demand charge is accessed during the hours between 12 noon and 8:00 P.M. During this time interval the maximum power demand that NIST places on the utility group for a single 30 minute interval during the entire month is charged $9.88 per kW. Note that during the summer months if NIST's peak power demand takes place between the hours of 12:00 noon and 8:00 P.M, every 1 kW of demand is costing $13.95. If we could reduce the maximum demand by 1kW (for example by cutting off 10-100 W light bulbs during this time interval NIST would save enough money to run the same load (10 lights bulbs in this example) for approximately 500 hours during non-peak time intervals. By realizing the significant economic implications that power demand has on our electric bill, strategies could be developed to shift significant electrical loads to reduce the demand charges. It is interesting to note the shape of the load duration curve for a typical summer month, Attachment B. The load curve is relatively flat except for approximately 5 percent of the time when the demand significantly exceeds the demand present for the remainder of the month. If we could anticipate the peak demand periods and shift loads to time intervals with lower electrical demands, the peak demand charge could be significantly reduced. Such strategies would not only benefit NIST, but the entire community by making power available to other customers during peak demand periods. The following ideas would reduce both peak demand and energy consumption at NIST.

Energy Accountability - Currently there is limited accountability for the energy consumed and the time at which it is consumed at NIST. All of us have observed cases of unused equipment, lights in unoccupied offices, etc. being left on for considerable lengths of time. The energy consumption and peak demand associated with each building should be measured and reported to the Lab Director responsible for that building. Incentives should be put into place to encourage the person responsible for each building to encourage energy conversation. It is my understanding that NIST currently has electrical sub-metering (down to the building level) in place. This capability could be used to establish the baseline electrical energy consumption and peak demands for the previous twelve months. Incentives would be based on reductions in energy/peak demand for each building. Incentives could include: Statements in the performance agreements of Lab Directors, monetary awards, and/or recognition at the Annual Awards Ceremony.

The current situation reminds me of a personal experience. When I moved to Gaithersburg to begin my career at NIST, I purchased a townhouse in a community that received master gas, electric, and water bills for the entire 100 unit complex. No matter how hard an individual homeowner strived to reduce their energy consumption, the impact on the entire bill was small. Soon the individual would give up on conservation efforts or move to a community with individually metered homes. **We need to move to a community with individually metered laboratories and energy accountability**.

Fenestration Unit Replacement - The original NIST structures use single-pane glass for windows. This represents a huge opportunity for energy savings. The following energy savings potential is based on a general purpose lab building such as Building 224. Building 224 has a total of 198 single-glazed windows (excluding the lobby area). The area of each of these windows is approximately 3.3 m^2 representing a total fenestration area of 654 m^2 per general purpose laboratory. According to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) the overall heat transmission factor (U-Factor) for single pane windows with a metal frame without a thermal break is 7.2 W/m^2 K. Thus during a 24 hour period (assuming an average outdoor temperature of 0 °C (32 °F) and average indoor temperature of 20 °C (68 °F)), over 18,082 kWh of energy are lost through the windows in the eight general purpose laboratory buildings. If these window units were replaced with double pane fenestration units with a low e-coating and a thermal break in the surrounding frame (U-Factor 2.84 W/m^2 K) the daily heat loss through the window units would be 7126 kWh or a savings of 10,956 kWh for one day!! According to the Energy Information Administration the average electrical energy consumption of a U.S. residence is 10,215 kWh. Thus the daily energy savings from upgrading the windows (for the cited conditions) for the general-purpose laboratories exceeds the average annual consumption for a residence. The vast majority of the remaining buildings (Administration Building, Building 301, the corridors connecting the buildings, etc) also have single glazed units. The heat loss through the glazing associated with these buildings may exceed those estimated for the general-purpose laboratories. In addition to reducing heat loss and heat gain, upgraded fenestration units would reduce peak demand, increase thermal comfort, and reduce solar heat gain and glare during the summer months. (Note – I am aware that the buildings are heated/cooled by central plant facilities that have coefficients of performance greater than 1). The energy savings are expressed in terms of kWh, as it is easier to grasp the potential energy savings).

Energy Conservation at Loading Dock Areas - There are many occasions when the loading dock's overhead door in each general purpose laboratory is left open resulting in conditioned air being lost to the outdoors environment. In addition to the overhead door being open, the doors that separate the loading dock area from the hall are also left open. This results in significant energy loss as well as fumes entering the buildings from delivery vehicles that are often left running. Air curtain systems should be installed and interlocked with the overhead door such that the air curtain system is activated whenever the overhead door is open. Perhaps, if related safety issues could addressed, automatic closures of these doors should take place after a given time interval of inactivity within the loading dock area. The swinging doors between the loading docks and general purpose laboratories should be modified and weather stripped to prevent the flow of air from the loading dock area into the building. Finally delivery, maintenance, and custodial personnel should be encouraged to close the doors.

Proximity Light Sensors - Proximity light sensors/controls should be considered for all offices. This would ensure that whenever an office is unoccupied for a set period of time the overhead fixtures would be turned off. This would reduce both the energy consumption and peak demand charges.

Lighting – The lighting fixtures throughout NIST should be upgraded from the current T-12 34 watt bulbs with magnetic ballasts to T-8 32 watt bulbs with electronic ballasts. This upgrade has occurred sporadically throughout NIST as personnel have requested upgrades. A concerted effort should take place to upgrade the lighting throughout NIST.

Computers and Associated Printers - Each office/cubicle should be equipped with an easy to use switch that would allow the occupant(s) to completely power down all office equipment within their workspace during the evening and weekends. At one time the storeroom offered a combined UPS remote switch that could serve this purpose well. I was disappointed to see that NIST management had reversed their position on shutting the computer off at night due to issues related to backing up the data stored on the computers. Surely there must be a way to back up the systems during periods of inactivity during normal working hours. According to the Environmental Protection Agency (EPA) a typical computer, monitor, and laser printer turned off all night will save $56.00 dollars compared to an Energy Star computer system and $137 dollars compared to a non Energy Star system left on continuously. Assume that there are 10,000 computers at NIST (approximately three per employee) and further assume that a third cannot be turned off as they are being used to control experiments, provide critical services, etc. If the computers were currently being operated in the energy saving mode, then the annual savings to NIST by shutting them during non business hours would be $373,000. In reality the savings would probably be substantially greater if the majority are not being operated in the energy savings mode. If an insignificant number are not currently being operated in the energy savings mode, the savings could be as great as $914,000 dollars per year. Although one could argue correctly that the heat being generated by this equipment is reducing the heating load during the winter, it should also be pointed out that it increases the cooling load during the summer months!

Energy Saving Model Office - Implementation of some of the above suggestions would require capital expenditures and effort. It might be prudent to implement these changes on a single office, a group of offices on a hall, or a complete general-purpose laboratory building. The energy consumed by the office, or selected group of offices, could be compared to offices that have not been modified. This would provide data that could be used to justify modifications to the entire NIST campus.