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Paper Session I-C - Reducing Launch Processing Cost Utilizing Energy Management Techniques

Christopher A. Cook
EG&G Energy Management Office

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Christopher A. Cook
EG&G Energy Management Office
BOC-194, Kennedy Space Center, FL 32815

Abstract

In order to be competitive with foreign and domestic launch services providers, every cost reduction tool should be utilized to the fullest extent. One method often overlooked is effective energy management. When considered from the original design concept, energy efficient devices and operational procedures can significantly reduce the operating costs of a launch/processing facility. Retrofitting energy efficiency into an existing facility will still provide significant cost benefits, however the payback period will usually be longer than if considered in the design. Many of the launch facilities in the Unites States were designed and constructed over 30 years ago, when energy efficiency was not a factor. There have been many exciting technical advances within the past five years regarding energy efficient devices and designs.

This paper will examine the most common energy conservation measures that can be utilized at launch processing facilities, discuss the performance of cost-effectiveness evaluations, and identify several implementation and financing techniques.

Introduction

In today's commercial and government launch environment, cost is becoming an increasingly important factor. To remain competitive (and in business), any method to reduce operating costs should be carefully evaluated.

One area that is often overlooked is Energy Management. Energy bills for launch processing facilities are a significant percentage of their operating costs, but are often viewed as a "cost of doing business", and ignored. Energy costs during Fiscal Year (FY) 1995 at Kennedy Space Center (KSC) totaled approximately 16 *Million* dollars. What makes this figure even more interesting is that the cost for electricity (the primary energy source) at KSC is one of the lowest in the country. A typical spacecraft processing highbay facility at KSC in FY 95 consumed over $220,000 in energy costs, and this was with an energy management program already in place. According to the Department of Energy, consideration of the site and program specific opportunities, energy-efficient equipment should allow a reduction of energy use by at least 5 0°/0 compared to buildings that minimally comply with federal energy standards.

In the 1970's the United States got its first wake up call as to high energy costs, and in many government facilities, the first mandate to reduce energy consumption. These activities typically involved setting back thermostats and removing lamps from fixtures. The end result of these measures was that minimal energy was saved, and personnel were made

uncomfortable. This left Energy Management with a bad reputation among personnel. Correctly applied energy conservation measures (ECM's), should ideally be transparent to facility occupants. They should be “designed into” the facility and require no extra effort from the users.

In the 1990’s, increased competition and rising energy costs spurned a new generation of energy efficient products and services. We learned that if energy saving equipment made people uncomfortable, any savings attained was more than offset by lower productivity. This new equipment not only reduces energy costs, but increases reliability, worker comfort and productivity while reducing maintenance as well. There are also environmental benefits to increasing energy efficiency. Old refrigerants used in HVAC systems which have been determined to damage the ozone will be replaced by new environmentally friendly refrigerants. Old fluorescent ballasts contain PCB’S, and newer lamps have much lower levels of mercury. Also with reduced electricity required, the utilities will use less fuel to produce the energy, which results in fewer emissions to the environment This is a true “win-win” situation. In addition, President Clinton signed Executive Order 12902 in March of 1994, which strengthened the existing Energy Policy Act (EPACT) of 1992. This order mandated that all federal facilities reduce energy use by 30% from 1985 levels as measured in energy (BTU’s) consumed per square foot per year 30% by the year 2005.

In evaluating the viability of energy projects it is important to remember that each project accomplished will continue to save costs during its entire operating lifetime, even after it has paid for itself. In order to implement an effective energy program, management support is vital. Nothing will get done without a strong commitment from management. The entire organization needs to become aware and involved. Every little measure adds up, and continues throughout the facilities lifetime.

There are two primary scenarios where energy efficiency is placed into the system: designed in before construction or retrofitted. Of course it is easier and less costly to consider energy efficient designs before construction, but most launch processing facilities are already constructed, with many being over 30 years old. These aged facilities were designed and constructed when energy efficiency was not considered at all, and offer the greatest opportunity for cost savings. Since most launch facilities are already constructed, this paper will deal primarily with energy efficient retrofits. These energy conservation measures will be classified into various groups and discussed.

Utility Charges

The first step in reducing energy costs is to understand how utilities bill users. Not only are users charged per kilowatt hours (kWh) used, but also for demand and peak time period useage. Demand charge is the fee associated with the highest power rate encountered for the billing period, even if it is only for one minute. For example if all of the facility equipment was turned on at one time for a specific test, and that event drew 100,000 kilowatts of power, the demand charge for the period would be 100,000 kWh multiplied by a demand charge multiplier.

Peak period charges are “extras” that the utility charges because they see the greatest (peak) demand during these times, typically from 8:30 a.m. to 1200 a.m. and 6:00 p.m. to 9:30 p.m. There may also be partial-peak time periods and rates in effect. By simply scheduling high energy use activities away from these two peak periods, significant savings can be realized.

One energy saving tool that is now gaining in popularity is negotiating a better rate from the utility. In this age of utility de-regulation it is entirely possible to “shop around” for a better energy bargain. In Michigan, the Chrysler corporation successfully negotiated an almost 50% reduction in their electrical costs by considering building their own Compressed Natural Gas (CNG) fired cogeneration plant. This is a very involved topic that would require an in-depth analysis of pricing, production, availability, market penetration, generating capacity etc.. However, in some cases it may be worthwhile to explore.

The second step in any search for energy reduction is a facility energy survey. This survey or audit will identify the major (and minor) energy consumers as well as operational activities. There are basically 3 levels of energy surveys, from walkthroughs to intensive data gathering, modeling, and analysis. These surveys will indicate where, when and how energy is consumed, and then propose methods to reduce these associated energy costs.

Low/No Cost Items

The easiest energy conservation methods are the low or no cost items. The most obvious is to TURN IT OFF WHEN NOT IN USE. As simple as this sounds, it is amazing how much equipment stays energized when not required. Sensors that automatically set back or turn equipment off will assist in this effort. Another common sense low cost measure is to keep equipment properly maintained and operated. Actions such as keeping filters clean, keeping rotating machinery properly lubricated, and operating systems within design parameters will save energy and money. Other measures take advantage of demand reducing and peak shifting methods mentioned previously. By performing operations during off-peak times, significant energy savings can be realized. There are other advantages to performing operations during off-peak times. In subtropical environments such as Florida, the nights offer personnel relief from the summer heat, and hazardous operations such as propellant loading/pyrotechnic installation can proceed with minimum impact from daily afternoon electrical storms.

Another low/no cost item is scheduling or programming energy intensive equipment to energize sequentially instead of all at one time (pumps, heaters, etc.). This will help to reduce peak loads.

Operationally, there are many opportunities to conserve energy. Clean Room and high bay strict temperature and humidity controls can be set back during periods when payloads are not present. This can be done automatically with the installation of Direct Digital Controllers (DDC) for HVAC Systems. Payloads often are shipped in environmentally controlled canisters. By leaving the payload inside the canister as long as possible, the processing facility’s environment can be set back for a longer period of time. Many operations leave

large high bay doors open for move operations for extended periods when not necessary. The installation of effective seals and air curtains in heavily utilized loading bay doors will reduce HVAC costs. The application of window tinting and interior storm windows, will reduce the heat load into the facility, in addition to making personnel more comfortable by avoiding "hot spots".

Occupancy sensors and timers for both lighting and HVAC systems typically are low cost and pay for themselves rather quickly (1-2 years). These devices sense when a room or zone is unoccupied and turns off the lighting or sets back the thermostat automatically. These devices can be Passive Infrared (PIR) or Ultrasonic for lighting systems, and carbon dioxide/Humidity sensors for HVAC systems. There are also daylighting systems which dim or turn off lighting when ambient levels through windows/skylights provide sufficient light. Energy efficient computers, copiers and office machines can be purchased with "sleep" mode features, which reduce energy consumption when left inactive for a period of time. They automatically "wake up" when called upon.

Lighting

Lighting improvements are one of the easiest measures facility operators can do to reduce energy consumption. Recent developments have greatly improved the quality and efficiency of lighting systems. Fluorescent lamps manufactured today are five times more efficient, last ten times longer, and operate at much lower temperatures than incandescent. This saves energy, HVAC, and maintenance costs. Standard 40 or 32 watt four foot fluorescent T12 type lamps with magnetic ballasts can be replaced one for one (and usually one for two) with high efficient T8 lamps with an electronic ballast and realize a 40% energy savings. T8 lamps are easily identifiable due to their slimmer (one inch) diameter. Compact fluorescent lamps and fixtures are now manufactured in so many styles and configurations that it is difficult to justify the use of any incandescent lamps. Advances in ballasts have also allowed dimming of fluorescent lamps, which is especially useful for task lighting applications, such as office cubicles. The increased use of task lighting allows for individual personnel to have more control over their own lighting environment, and provides an opportunity to reduce ambient light levels where practicable. Fixtures have also dramatically improved in recent years. The use of high efficiency computer designed specular (polished) reflectors in fixtures have allowed for less lamps to be required to achieve a desired lighting level. Compact fluorescent lighting is now effective in highbay and exterior applications with the use of reflectors. It should be noted that reflectors will require periodic cleaning to maintain their efficiency. Light Emitting Diode (LED) Exit signs can be purchased or easily retrofitted. Standard exit signs typically utilize two 20 watt incandescent lamps, which have a rated life of approximately 1 year. LED exit signs typically consume only 3 watts and have rated lives of 25 years. Recent advances in high intensity discharge (HID) lighting has also made mercury vapor lights virtually obsolete.

Daylighting

Possibly the most underutilized energy conservation measure (ECM), is daylighting. Daylighting is the use of ambient sunlight through windows and skylights. Not only does

daylighting emit high quality, pleasant illumination, it also provides maximum light at peak load times, when electricity is the most expensive. New high efficiency heliostatic and tubular skylights are now available that can bring much more light into a facility than standard square skylights. Heliostatic skylights employ polished aluminum mirrors which track and focus additional sunlight into a diffuser lens in the bottom of the skylight. Tubular skylights utilize thin metallic cylinders with a highly reflective coating on the interior surface. This provides for a greater portion of light to be brought down the tube to the diffuser lens on the bottom of the cylinder. These cylinders can be lowered down to over 8 feet from the ceiling to provide task lighting. When combined with dimming circuits controlled by photocells, daylighting can significantly reduce demand during peak hours. Almost any facility can easily be retrofitted with these systems.

Electric Motors

Electric motors consume the most electricity in the United States. It is important to note that newer high efficiency motors (designated "EE'')are more expensive than standard motors. It should be realized that over the life of a motor, the purchase cost is only a fraction of its total operating costs. In other words, the additional cost of a premium efficiency motor is recovered in the first few years of operation, and continues to pay dividends over the life of the motor. Motor applications at launch facilities include propellant pumps, HVAC air handlers, sump pumps, etc. Many motors at older installations are oversized. When examining motor replacements, verify that the actual maximum load is close to the rated load. If the load on the motor varies quite a bit, consider replacement with a two speed motor, or an Adjustable Speed Drive (ASD) unit. ASD's will vary the output of the motor to match the load, reducing wasted motor power. New motors now have ASD controllers built onto them in horsepower ratings as low as 5. Another method in improving efficiency of electric motors is to verify that the shaft alignment is correct. If the shaft is off alignment by just a small amount, the efficiency can be significantly affected. New Laser alignment techniques can be performed quickly and in-situ to minimize downtime. It should be noted that premium motors also operate with less noise, vibration, and heat generation. This provides for longer life and reduced maintenance costs.

Building Envelope

Building envelope is making sure that the building is well insulated and has minimum air intrusion/extrusion. Building envelope retrofits include the application of foam spray on roofing for additional insulation, window tinting, interior storm window, and air curtain installations mentioned previously.

Heating, Ventilating, and Air Conditioning (HVAC)

HVAC systems most likely consume the largest share of energy costs in launch processing facilities. Many activities require strict temperature and humidity control. These systems are also usually are the most expensive to maintain.

One method of increasing efficiency of HVAC systems is the utilization of Variable Air

Volume (VAV) air distribution systems. VAV systems have controllers in the ducting system that will regulate the amount of conditioned air that enters specific areas (rooms, high bays, etc.). This allows for a more efficient use of energy because the conditioned air is directed only to where it is needed.

Other HVAC efficiency items concentrate on reducing the humidity in the air, especially in subtropical launch environments (Florida, French Guiana, Tonegashima, etc.). Dehumidying takes the most energy in the air conditioning process. Such devices include heat pipes and desiccant wheels. These devices use minimal or no energy by utilizing the return air flow to pre-cool the incoming air. It is interesting to note that heat pipe technology was developed by the aerospace industry for temperature control of satellites.

New chillers operate at over twice the efficiency of models 10 years older or more. They also employ environmentally friendly refrigerants that will be economically available (and legal) for many years to come. The new units also have about half the moving parts of older units, increasing reliability and maintainability. These chillers usually qualify for rebates from utilities.

Thermal Energy Storage (TES) systems provide the capability of producing ice or slush in storage tanks at night, and then utilize the ice to provide air conditioning during the day. This technique takes advantage of demand side programs that offer cheaper electricity at night. Many new facilities (the Orlando City Hall, for example) have successfully incorporated TES systems. Other advantages of TES systems are reduced duct/air handling motor sizes, generous utility rebates, and better humidity control. However, TES systems are not usually economical for 24 hour operations.

In fine-tuning the efficiency of HVAC systems, facility operators should be careful to fully comply with all codes and standards for Indoor Air Quality (IAQ). “Sick Building Syndrome” has become a major source of litigation for facility operators, and the cause is usually related to the improper operation or maintenance of HVAC systems.

Energy Management Systems

There are many energy management systems currently on the market which automatically control the lighting and HVAC for facilities. These can be used for turning off equipment, peak load avoidance, and demand shedding. There are currently energy management systems on the market which have demand limits programmed into them which cycle non-critical equipment off to reduce demand. For example, if a high rise building was reaching a preprogrammed demand limit, the controller would cycle off air conditioning in elevator shafts, stairwells, and certain zones in the shaded side of the building in 5 minute cycles. Although unnoticed by the tenants, these systems typically provide enough energy savings for payback periods of less than one year.

Other energy management systems allow for the monitoring and control of the entire facility HVAC systems through a personal computer (PC). These systems not only provide for ease of operation, but also are an excellent record of system performance for evaluation of future

efficiency improvements, and as evidence of Indoor Air Quality (IAQ) compliance.

Alternative Fuels

Another method of reducing costs is to utilize alternative fuels or renewable energy sources where practical. The main alternative fuel utilized is Compressed Natural Gas (CNG). This clean burning, readily available fuel can reduce demand charges when employed for HVAC and hot water generation. Energy efficient gas fired chillers offer operators increased flexibility in demand and fuel charges, especially in negotiating utility rates. CNG fueled boilers reduce maintenance by orders of magnitude over oil fired units, and minimize toxic emissions. CNG fueled cogeneration plants can provide a facility with all their electrical power, and may even sell excess generating capacity to a utility. This is usually only practical for large facilities with 24 hour operations and a nearby need for hot water. Renewable energy sources such as solar and wind power offer advantages at remote sites where grid power is not installed, and thus provide limited applications at launch facilities. Successful applications at KSC include solar powered parking lot lights at a tracking station and weather data gathering stations.

Financing

The preceding items are just the tip of the iceberg on ways to reduce facility energy costs. The major hurdle in implementing these measures of course, is cost. It is important to realize that energy efficiency projects are evaluated on among other things, a "payback period". This is the time required for the project to pay for itself through the energy costs avoided by the projects implementation. Executive Order 12902 states that all energy projects with a 10 year or less payback period should be implemented in federal facilities. However, most energy projects implemented typically have payback periods of 6 years or less. It should also be noted that energy projects provide cost savings *each year for the life the facility*. That is why Life Cycle Costing (LCC) should be utilized, Additionally, utility costs usually rise over time, which will further increase the savings. Fortunately there are many financing methodologies that will provide the funding for installation of energy efficient equipment.

Utility companies offer many rebates for the installation of energy efficient products. These rebates vary from utility to utility, but can significantly reduce the payback period for energy projects. KSC qualified for approximately $212,000 in utility rebates for FY 95 projects.

In order to justify the cost of implementing energy projects, be sure to include the reduced maintenance costs and environmental/regulatory benefits, in addition to the energy savings. For example, reduced energy costs may be significant to management for replacement of an aging HVAC system, however avoiding expensive litigation regarding an Indoor Air Quality (IAQ) issue, and availability of outlawed refrigerants may be more important. It pays to work with the legal, environmental and safety people when proposing facility projects.

After a life cycle cost analysis is performed and a good baseline for consumption is obtained, there are many Energy Service Companies (ESCO'S) that specialize in the financing and

installation of energy projects. Some utilities even operate their own independent ESCO'S. Facility owners typically pay for the complete purchase and installation of equipment through the energy savings obtained. These are commonly called Energy Savings Performance Contracts (ESPC'S). For example, if a relamping project will save a facility $1,000 a month in energy costs and the ESCO'S installation fee is $18,000, the facility owner would pay the ESCO $1,000 each month after installation for 18 months (1.5 years). This money would normally have been paid to the electric utility. After the 18 month time period was up, the facility owner would fully realize the $1,000 savings each month for the life of the facility. The benefit of this type of contract is that no up front funds are required and no additional funding requests will have to be made. Facility owners should be careful to select a qualified, stable ESCO with certified credentials and references. There have been some reported instances where ESCO's were claimed to have excessively sacrificed personnel comfort and lighting levels to obtain consumption reductions, or favored certain products that were technically inappropriate because the ESCO had an interest in them. A good strategy is to have an independent energy company perform the energy audit and identify potential projects, and then have a qualified ESCO verify the energy savings numbers and implement the projects.

Whatever financing technique is used, the most important consideration is to get energy conservation measures installed. Savings cannot be realized until they are in operation. Even if minimal funds are available, there are many low/no cost items that can be implemented, as well as an Energy Awareness program. Top management commitment is mandatory for a successful program. There are many new designs on the market that are easy to install and very effective and reliable. Energy management should be transparent to personnel. If safety and comfort are compromised, any energy savings will be lost due to drops in production.

In closing, remember that whether you implement an energy management program or not, your competition will.