The Fundamentals of Design for Proper Energy Conservation

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PROPER ENERGY CONSERVATION DESIGN

Energy consumption in buildings can be reduced by designing more energy-efficient building components. Reducing a building's energy usage lowers utility bills, benefits the environment, and also makes occupants more comfortable. Many of these energy-efficient building components interface with the building envelope, requiring understanding of building envelope design and energy-engineering best practices.

In order to install the right solutions at the best value with the lowest risk, a holistic approach must be used to create a customized solution. Energy efficiency and renewable energy projects are a complex combination of trades, engineering disciplines, and finance. They consist of a combination of electrical and mechanical systems; building envelope systems such as roofing, waterproofing, glazing, and insulation; utility tariff and regulatory requirements; LEED® requirements; energy tax credits and other tax incentives; energy retrofit strategies; operations and maintenance considerations; energy financial analysis; and structured finance and energy service agreements.

To maximize return on investment (ROI), an energy project should follow a "conservation before generation" approach designed to account for the net effect of energy conservation measures (ECMs) on energy generation system sizes (*Figure 1*). This proper "loading order" must be followed in engineering and analyzing each technology.

Proper ECMs can reduce utility expenses in a cost-effective manner by at least 20% and as much as 50%. Then, generation opportunities are explored to offset the remaining utility expenses. By first focusing on energy efficiency and reducing the amount of energy used, the owner can use a smaller energy generation system. ECMs typically have a lower capital cost and higher ROI than generation technologies. However, conservation technologies cannot achieve the same amount of utility bill savings that generation technologies can: You cannot conserve your way to a "zero" utility bill, but you can generate your way to zero. Therefore, to maximize the savings and the ROI, the proper sequence is to conserve first, then generate.

For these proposed energy systems and revenue-generating systems to stand the test of time, both energy system design and integration of the system into the site (which is often neglected) must be taken into account. Without a mutual combination of these two best practices, the project will not be truly sustainable or responsible. Improper integration of new equipment is the chief failure point for alternate and renewable generation systems, resulting in inefficiency and often leading to water intrusion leaks, structural failures, electrical faults, and environmental damage in addition to fines. These failures can lead to a complete loss of economic value. For example, improper installation of a high-efficiency glazing system can lead to water intrusion. Similarly, improper integration of

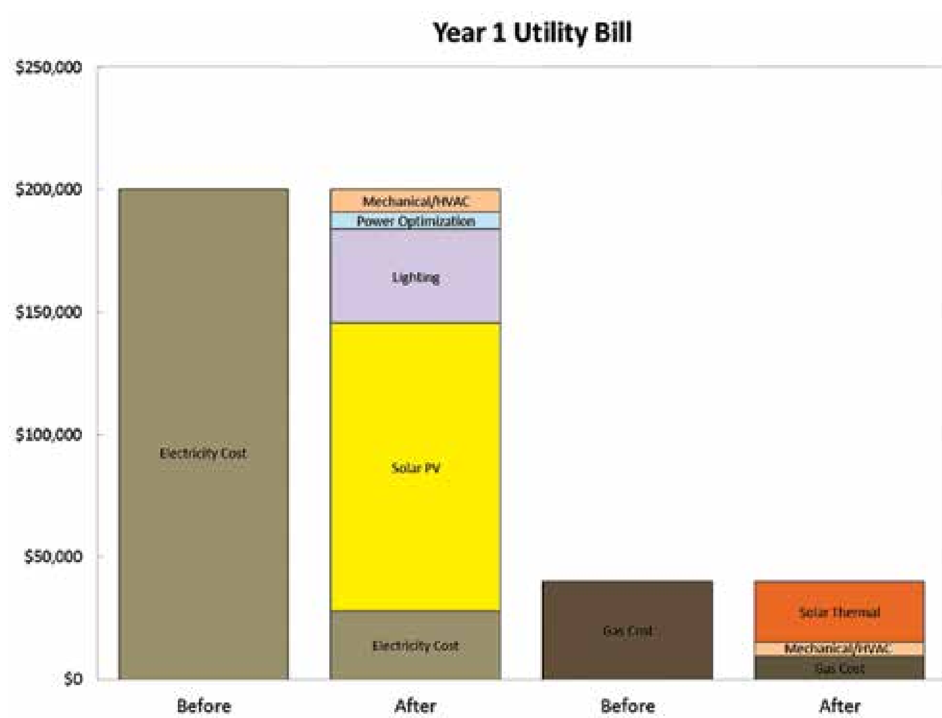

Figure 1 – Year 1 comparison of utility expenses before and after a conservation and generation project.

a solar PV racking system into the underlying roof structure and waterproofing membrane can lead to water intrusion, and the projected energy savings and ROI can easily end up in the red in both cases from poor performance and maintenance and repair costs.

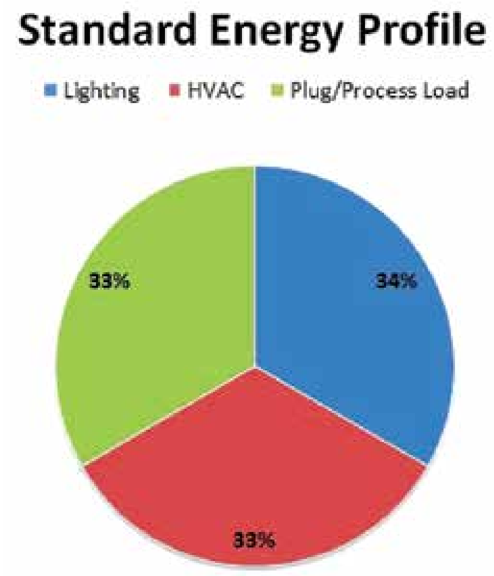

Figure 2 – Standard energy profile: Even lighting, HVAC, and plug loads.

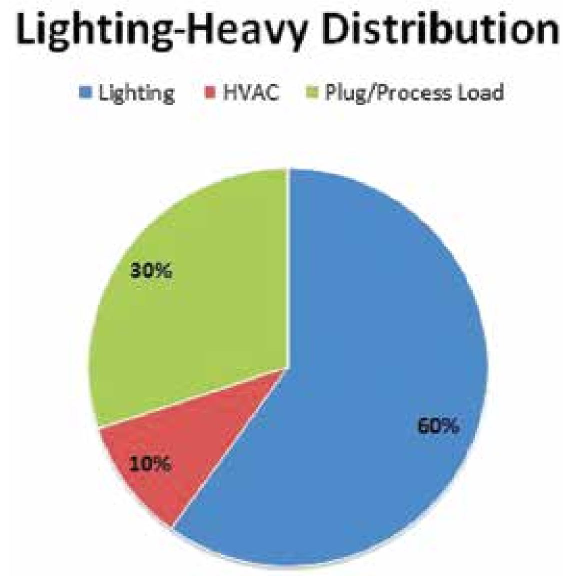

Figure 3 – Lighting-heavy profile: 60% lighting, 10% HVAC, 30% plug/process.

ENERGY CONSERVATION SOLUTIONS

The objective of energy conservation solutions is to use less energy but provide the same or better level of energy service. The main building components that are optimized for energy conservation are lighting and electrical, mechanical, hot water, and building envelope systems.

To develop an energy conservation strategy, it is first important to understand the energy profile of the building. The first step should be a screening analysis by an energy engineering team to perform a preliminary analysis to screen the project and guide the focus. The energy engineer must have experience with and expertise in building energy analytics. This includes an early stage determination of the following:

1. The owner's energy and financial objectives
2. Utility consumption and expenditures relative to benchmarks
3. Year, type of construction, and other basic information
4. Applicable building and energy code requirements
5. Identification of categories of ECMs and potential costs and savings in each category based on ratios from similar buildings

The screening analysis will establish a preliminary range of yield on investment. With this information, ECM opportunities can then be evaluated and ranked so that the project focuses on solutions, if any, that make sense given the financial objectives and energy code requirements. The preliminary analysis thus provides a low-cost way to determine a "go/no-go" for a detailed investment-grade audit (IGA) and lowers risk to the owner in expending additional monies.

Based on a "go" decision from the owner after reviewing the preliminary analysis, the second step involves an IGA. An IGA includes detailed specifications for the recommended ECMs, energy savings analyses, turnkey installation costs, and financial analyses. IGAs typically include a full life-cycle cost analysis (LCCA), which considers initial investment cost, energy savings, scheduled maintenance savings (if any), and end-of-life salvage/disposal, if appropriate. An IGA takes the guesswork out of the energy audit and upgrade process and significantly shortens the implementation cycle for clients for the following reasons:

1. An IGA provides ROI projections that the client can rely on for decision-making.
2. When utilizing hard costs in the IGA, the client can move directly to contract for the specified systems.

Given that a typical IGA can be time- and cost-intensive, it should only be performed after the preliminary screening analysis is completed.

TYPICAL BUILDING ENERGY PROFILES

A standard building is one in which consumption from lighting, mechanical, and plug load is divided approximately equally into three categories. Lighting retrofits, combined with low-cost mechanical energy-efficiency measures or retrocommissioning, create a better yield for this type of building. The energy categories are described in the graph in *Figure 2*.

One type of building is a lighting-heavy building, where the lighting portion of total energy consumption is estimated to be 50% or more (*Figure 3*).

A lighting-heavy energy load project is characteristic of a garden-style, multifamily building with direct tenant metering and open breezeway circulation. For such a site, a lighting project is the first place to start in sequence of an energy retrofit project.

Lighting

One of the simplest ways to lower electrical usage is to upgrade to more efficient lighting technology. A well-designed lighting project could achieve more than 50% reduction in lighting energy, and 15% to as high as 40% reduction in the entire electric utility expenditure for the year. Lighting projects typically have an ROI of 20 to 30%, and a payback of two to four years. The energy retrofit of site lighting has to take into account not only the type of light to be replaced, but also its application area, code requirement, etc. A lighting ECM can range from simple lighting replacements to more complex control system designs. Efficient lighting lowers energy costs, helps the environment, and improves productivity because it more closely resembles natural light. Modern lighting delivers better-quality light with improved color and less flicker, lasts longer, runs cooler, and can decrease demands on HVAC systems. Installing energy-efficient lighting can also reduce the costs of compliance with greenhouse gas regulations, help to meet LEED® green-building certification, and make the facility eligible for energy tax credits.

Before improving lighting efficiency, a lighting audit is performed, which typically consists of collecting data such as quantity and type of existing fixtures, lighting power

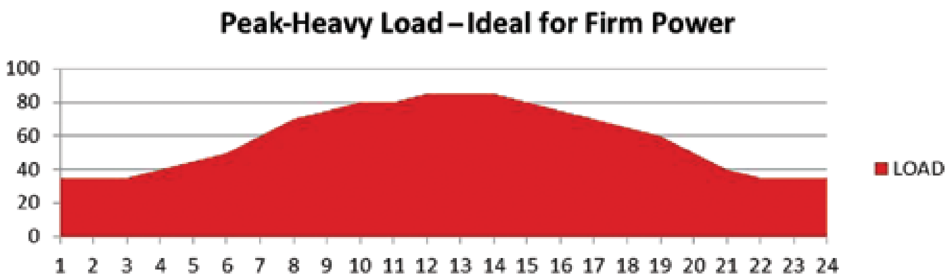

Figure 4 – Peak-heavy load profile across a 24-hour cycle, such as at an industrial facility.

density (LPD) calculations, intended use of the space, dimming capacity, daylighting and load-shedding potential, maintenance costs, and available utility and tax incentive programs.

After analyzing the audit results, energy-efficient solutions are targeted, such as light-emitting diode (LED) bulbs and high-efficiency fluorescent bulbs, as well as lighting controls. Lighting controls can be integrated with on-site demand response systems, which interact directly with the utility provider to reduce power consumption on demand and take advantage of time-of-use pricing, peak-energy pricing, and utility rebates.

Power Optimization

Another option for managing electrical usage and demand is power optimization. Power optimization makes motors and induction loads run more efficiently. When motors run more efficiently, they demand less energy, which reduces demand charges. Power optimization can reduce demand by 5 to 10%, with paybacks in fewer than three years. Optimization appears to pose little to no risk to the facility during or after construction and has a positive cash flow from Day 1.

Mechanical Optimization

A building's mechanical systems can consume 30 to 60% of the structure's total supplied electricity and provide a significant opportunity for capturing energy savings. ECMs for complex mechanical optimization projects can yield around 30 to 50% reductions in mechanical energy usage for large central-plant and air-handling retrofit projects. Installing state-of-the-art mechanical equipment and control systems may provide the lowest life cycle investment and best return by helping to avoid the endless cycle of overhauling and retrofitting older equipment.

A prime example of this mechanical equipment is the ductless variable refrigerant flow (VRF) system. VRF systems are a type of HVAC system that provides buildings with simultaneous and efficient heating and cooling, minimizing energy waste, and reducing building HVAC operational costs. They can also be granted LEED® credit points for designing sustainable buildings in the Energy and Atmosphere and Indoor Environmental Quality categories. Since VRF systems use a variable-speed compressor compared to a single-speed compressor, energy use is decreased because the compressor can ramp up or down in small increments, as opposed to being switched on at full bore and then being stopped repeatedly to meet the thermal demand. In addition, the indoor units provide the precise amount of heating or cooling for optimal occupant comfort.

Hot Water

The third building component for energy savings opportunities is the domestic hot water system, including the boiler, boiler pumps, reheat systems, and circulation pumps. The energy conservation lies in making the supply and demand curves of hot water match. The system is designed to provide water at all times, but the boiler aquastat temperature may be set too high, the circulation pumps may be operating at 100% power all the time, and boiler pumps may also be continuously operating at 100% power, independent of the time of day or demand.

One means of accomplishing efficient hot water performance is with a demand controller. This device controller lowers the energy consumption of the entire hot water system by preventing the pumps and the boiler from running continuously. The demand controller has built-in safety, which allows for a system override in the event that demand spikes, at which point the controller lets the boiler system operate at full capacity to meet demand.

Building Envelope

The final aspect of energy conservation is the building envelope, which is the most common area of building failure and reduced energy performance. Premature building repairs unnecessarily consume our natural resources, adding pressure to already overburdened disposal facilities and leaving a large carbon footprint from the manufacture of replacement materials. Building leaks from failed waterproofing systems cause mold and are a potential health and safety hazard to occupants, as they accelerate the deterioration of these systems and their efficiency. Poorly insulated and constructed buildings, dark-colored roofs, and older HVAC systems consume vast amounts of electricity during daily operation. Examples of envelope ECMs include improved roof insulation or improved exterior insulation, such as continuous rigid insulation. Adding an additional R-10 value to exterior wall systems would be approximately two inches of additional insulation. Improving glazing by reducing solar heat gain coefficient (SHGC)—either by changing window type and/or tinting—can also lead to significant energy savings. However, many building owners are hesitant to invest in building envelope ECMs because most do not have an apparent and tangible ROI. Proper energy conservation design and modeling can demonstrate the benefit of these upgrades.

ENERGY GENERATION SOLUTIONS

An energy project is typically not complete until the remaining energy load after

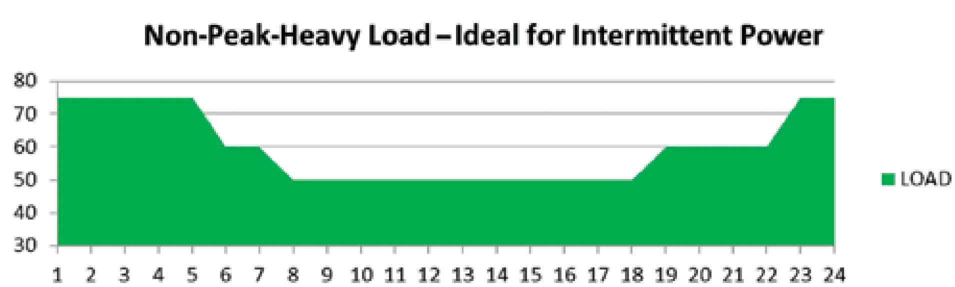

Figure 5 – Non-peak-heavy load profile across a 24-hour cycle, such as in a multifamily building.

conservation is reduced using the correct energy generation technology (assuming there is appropriate space on site to install the solution). There are two major categories of energy generation: firm power and intermittent power. Firm power is provided by an on-site generator and is similar to power from the utility company—always available. Intermittent power is renewable energy—available sometimes, when the sun is shining or the wind is blowing. Multiple types of generation can be deployed at the same site, and the exact type or combination of energy generation deployed depends on many factors, including available space, the cost of electricity and natural gas or propane, and the profile of the remaining energy loads after energy conservation solutions are implemented. For daytime-heavy loads, firm power can be used; and for loads that have a morning and night-heavy profile, intermittent power is often appropriate. The two curves of the peak-heavy and non-peak-heavy load profiles are shown in *Figures 4 and 5.*

Firm Power

Cogeneration (also known as combined heat and power or CHP) is the typical firm-power choice and refers to an on-site generator with a fossil fuel source powering an internal combustion engine or a fuel cell. It produces power and a heat byproduct, both of which must be used on-site in order for the plant to operate at the high efficiencies that make financial sense. Cogeneration is capable of reducing space heating, domestic hot water, and pool heating loads. The technology can reduce electricity expenditure by 50 to 60%. In the right applications, the generator produces sufficient heat energy that is captured and reused on-site so that the electric power from the plant is considered almost "free."

Examples of peak-heavy load buildings that are ideal for cogeneration are industrial facilities and large high-rise office buildings. The reason peak-heavy loads need firm power is because of utility rate structures. Energy charges are high during the peak-demand period and low during non-peak-demand periods. In order to offset the peak-period demand, which is significantly higher than the non-peak-demand period, the power source should be able to maximize its production during peak.

Intermittent Power

Solar photovoltaic (PV) systems reduce energy costs by converting sun rays to electricity. Typical PV projects have a life span of 25 to 30 years, therefore allowing for long-term energy master planning. With improvement in PV technology, high efficiencies, and lower cost, it is a financially viable method for offsetting up to 95% of a utility bill. The high offset is possible due to energy arbitrage, whereby kilowatt hours (kWh) generated at high value during the day are exported for credit, and then those kWh are consumed at night at a lower value. In the case of PV technology, the utility grid acts as an artificial energy storage if there is net energy export.

Solar thermal technology reduces energy costs by heating water using the sun's natural energy. It works by concentrating the sun's heat into a collector system. Water is then passed through the collectors, heated, and stored in tanks on site. When hot water is needed, the stored hot water is used instead of the natural-gas boiler system. Solar thermal systems' peak efficiencies are achieved at quantities that offset approximately 70 to 75% of the natural gas or electric heating energy of a site.

Examples of buildings with non-peak-load profiles are multifamily buildings, hotels, and buildings with a lot of exterior lighting (which only comes on at night), and some low-rise commercial office buildings.

ENERGY AUDITS

As mentioned earlier, an audit is a tangible way to identify the most efficient energy-saving options and to provide tangible ROI for the client. The typical energy audit process first begins with the client stating his or her financial and energy savings goals. Once those goals have been defined, a preliminary analysis is performed, which typically includes a benchmark analysis and audit of current natural gas, electric, water, and waste systems. From the results of that audit, certain upgrades can be identified; and, based on the project's viability, life cycle, and cost analysis, a comprehensive energy program will be developed. After deciding upon which upgrades to pursue, funding and procurement strategies are explored, and then, finally, the new energy systems are implemented.

Before any energy-efficiency project can start, a benchmark analysis is performed. The analysis gives building owners an accurate picture of the options for improving their buildings' performance and energy efficiencies. Comprehensive benchmark analyses cover mechanical engineering, lighting, and heating efficiency solutions. It helps to identify ways to lower maintenance and operating costs, improve ECMs, and increase overall financial rate of return.

The integration of financial analytics,

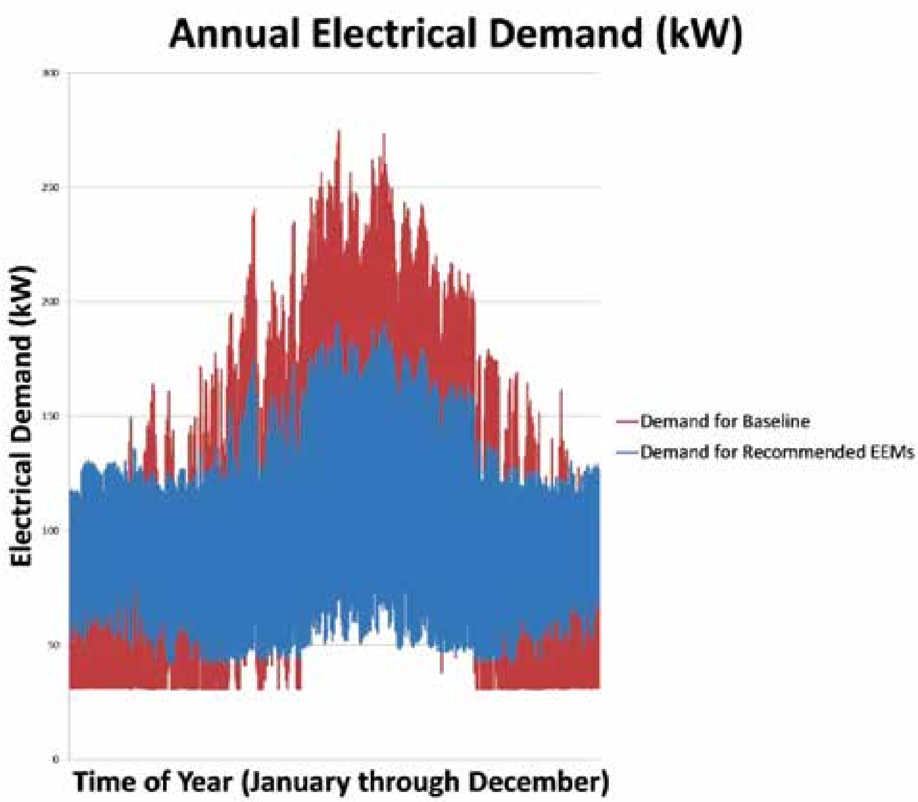

Figure 6 – Energy model results showing lowered baseline and peak demand.

FIM #	FIM Description	Electricity Cost ($)	Natural Gas Cost ($)	Total Energy Cost ($)	Annual Energy Cost Savings ($)	Annual Energy Cost Savings (%)
Anticipated Energy Efficency Measure Annual Cost Savings						
	Baseline (LGS-2)					
Base	ASHRAE 90.1-2007, PTHP, 80% Boiler, 0.9 LPD avg.	$ 111,760	$ 10,263	$ 122,023	$ -	0.0%
	Proposed					
Performance	Mitsubishi VRF with ERV, Reduced Lighting, Good Insulation	$ 86,086	$ 10,397	$ 96,483	$ 25,540	20.9%
	FIMS / EEMS					
1a	*95% efficient boilers	$ 86,086	$ 8,802	$ 94,888	$ 27,135	22.2%
1b	*VRF with ERV, intermittent fans	$ 76,618	$ 10,397	$ 87,015	$ 35,008	28.7%
1c	*VRF with ERV, ECM motors	$ 82,259	$ 10,397	$ 92,656	$ 29,367	24.1%
1d	Demand Control Ventilation (DCV)	$ 86,077	$ 10,397	$ 96,474	$ 25,549	20.9%
2a	*Add R-10rigid on exterior	$ 84,275	$ 10,397	$ 94,672	$ 27,351	22.4%
2b	Add R-20 rigid on exterior	$ 83,891	$ 10,397	$ 94,288	$ 27,735	22.7%
2c	Add R-15 rigid on roof	$ 85,392	$ 10,397	$ 95,789	$ 26,234	21.5%
2d	*Add R-35rigid on roof	$ 84,944	$ 10,397	$ 95,341	$ 26,682	21.9%
2e	Add R-50 rigid on roof	$ 84,850	$ 10,397	$ 95,247	$ 26,776	21.9%
2f	SB70XL Glazing (U=0.29, SHGC=0.32)	$ 86,375	$ 10,397	$ 96,772	$ 25,251	20.7%
2g	SB70XL Glazing (U=0.29, SHGC=0.24)	$ 85,132	$ 10,397	$ 95,529	$ 26,494	21.7%
2h	SB70XL Glazing (U=0.29, SHGC=0.17)	$ 84,144	$ 10,397	$ 94,541	$ 27,482	22.5%
2i	*SB70XL Glazing (U=0.29, SHGC=0.14)	$ 83,776	$ 10,397	$ 94,173	$ 27,850	22.8%
3a	*Shading on Roof from Solar Components	$ 85,599	$ 10,397	$ 95,996	$ 26,027	21.3%
3b	*Solar Thermal (35% solar fraction): 24panels, 1450gal storage	$ 86,086	$ 5,721	$ 91,807	$ 30,216	24.8%
3c	Solar Thermal (70% solar fraction): 48 panels, 2900 gal storage	$ 86,086	$ 2,641	$ 88,727	$ 33,296	27.3%
3d	Recommendation EEMS (denoted by * EEM items)					
	CREDITS IN ADDITION TO RECOMMENDATIONS					
4a	*Power Conditioning (3.4kW reduction, 29,784kWh reduction)	$ 70,553	$ 5,721	$ 76,274	$ 45,749	37.5%
4b	*LED Lighting Package (0.35 LPD avg.)	$ 61,389	$ 5,721	$ 67,110	$ 54,913	45.0%
4c	*Lighting Controls (10% lighting power reduction per ASHRAE)	$ 60,450	$ 5,721	$ 66,172	$ 55,851	45.8%
4d	*Solar PV (205.32kW DC system)	$ 34,483	$ 5,721	$ 40,205	$ 81,818	67.1%
4e	Expected Energy Performance (denoted by all * items)					

Figure 7 – Projected utility savings of $81,000 prior to rate escalation were $88,000 at date of expected construction completion. Does not include projected maintenance savings.

the client's energy profile, and energy modeling are essential in providing the client a cost-effective and efficient solution. A complete analysis of a client's energy profile, the cost of energy to the client, as well as savings/production modeling and the value of renewable technologies are all considered. Complex energy rate tariff analyses are used to determine the optimal rate tariff to extract the maximum benefit possible for the proposed renewable technology installation. Energy analytics generally include detailed production modeling and forecasting, assessment of existing site and meteorological data sourcing, and quality determination.

Energy conservation technologies are often incentives by federal or state governments and/or utilities, and these incentives are typically structured as available rebates. Renewable energy systems in the United States and its territories are primarily incentivized using tax credits and benefits. In order to maximize such tax benefits, custom financial analyses and financing solutions are a mandatory requirement and critical to delivering the lowest possible cost of power per kWh. In particular, energy generation investments are often staged over time, requiring intense coordination between the technical and financial structuring sides of the team.

Financial models are used to test various scenarios that are typically run to determine the sensitivity of individual model assumptions, such as power prices, construction costs, etc., on the project's potential return. Power pricing is based upon a complete understanding of the tariffs and an accurate determination of avoided-cost supported by time-of-use modeling. Based upon this information, the project's financial model is created.

CASE STUDY

Our case study is based on a 70,000-sq.-ft. skilled nursing facility in Las Vegas, Nevada. The owners were seeking to increase long-term energy efficiency while minimizing upfront costs. The owner was seeking to finance a comprehensive set of energy conservation and generation measures (collectively called facility improvement measures or FIMs), through annual savings on energy and operations over a 15-year payback period. A tailored design and approach for the energy project were developed to ensure the cost-effective measures and equipment were maintained over the system's lifetime while still generating positive cash flow from Day 1.

The first step was to perform a comprehensive analysis to determine where energy use could be reduced and the most efficient way to lower operating costs. The equipment descriptions, conceptual drawings and specifications, construction information, cost savings and projections, financing terms, LCCA, and implementation schedule were taken into account while performing the energy audit for the site. The analysis helped to develop an energy facility profile and to understand how, when, and where energy is consumed and where the most benefits can be obtained.

Since the site was seeking to achieve a LEED® Silver certification, Allana Buick & Bers' (ABBAE's) approach was heavily focused on benchmark analysis and modeling to analyze baseline and utility consumption in the areas of electricity, natural gas, and water. Benchmarking is a way of comparing a building's energy usage to buildings of similar type and function. First, energy usage intensity (EUI) is calculated on a per-square-foot index, and the EUI is then compared across various similar buildings in the same region. This helps to identify which buildings have greater energy-saving potential. In order to create a baseline for performance, the building envelope; mechanical, electrical, and plumbing (MEP) specifications; occupancy schedule; and ASHRAE data were each considered. By creating a baseline model of the building's energy usage and matching it to the utility tariffs, the utility costs could be determined (*Figure 6*).

Relevant building codes and construction drawings were reviewed in addition to the MEP components. It was determined that multiple building and technology improvements would result in significant energy savings. The analysis helped bring some hidden items, such as insulation and glazing, to light that were not obvious upon a first look. Each of the improvements was isolated and tested to precisely determine exact savings.

In addition, five simulations were modeled to further test and refine results. Initially, the goal was to lower energy usage before adding in alternative energy measures so that smaller equipment and systems could be utilized.

KEY FINDINGS

Several energy-reducing measures were provided that projected reduction of the site's energy consumption by 59% compared to its current baseline (*Figure 7*). In the first year, the measures would save the client $110,000 ($88,000 in energy and utility costs [assuming 5% utility cost escalation] and $22,000 in operations and maintenance), totaling $2,200,000 over 15 years and nearly $6,000,000 over its lifetime of 30 years.

The initial focus was the building insulation, as the audit revealed hidden savings for this building component. Various levels of insulation were analyzed to see which amount would register the greatest savings (*Figure 8*), and it was decided to apply an additional R-10 to reduce the walls' peak solar load by 50%. Insulation was applied in a continuous barrier across the exterior walls to prevent unwanted heat gain. By using appropriate insulation and choosing proper glazing types, peak solar loads could be reduced by approximately 45% from the baseline, reducing peak cooling demands.

Finding and selecting the proper roof installation was one of the most important measures in reducing energy consumption. Because the roof occupied such a small amount of volume as opposed to its footprint, it was the optimal place to make a large impact on energy savings. Additional insulation had the potential to reduce roof conduction loads a further 90% from the code baseline insulation.

Next, the focus was on mechanical improvements, specifically the building's HVAC system. Previously, the fan coils were running continuously because the energy recovery ventilators (ERVs) were connected to the negative (return/exhaust) side of the fan coil. Although it initially costs less to build a system designed like this, the system uses much more energy, resulting in higher electric bills and effectively negating the original cost savings. The design approach was modified so that the fan would be able to run intermittently and dramatically save on energy.

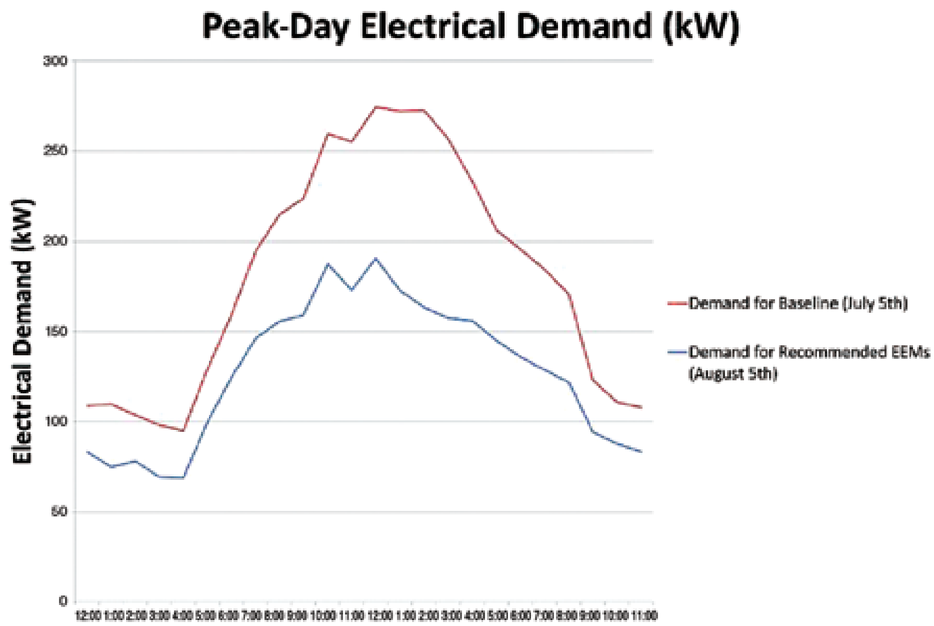

Figure 8 – Energy model results showing lowered peak-day electrical demand.

After energy use was reduced, the design of alternative energy generation systems was developed. Because the site had to regularly perform large loads of laundry and dishes, its domestic hot water (DHW) loads were quite high. As an alternative to the current gas boilers, a solar thermal solution that took advantage of the high amount of natural sunlight Nevada receives was developed. The solar thermal solution eliminated about 70% of the site's DHW energy load.

In addition to electricity considerations, an additional goal was to lower the site's water usage through improved landscaping and water-saving fixtures. Although the site's landscaping was originally designed to consume very little water, through the addition of a satellite-based control system, the site was able to reduce water consumption by an additional 20 to 80%, depending on the plant and the time of year.

High-efficiency, low-flow fixtures and water closets were each able to save 30% on the water bill, while high-efficiency shower heads reduced water usage by another 30%.

In order to maximize savings, a tariff analysis was performed to establish the baseline rate tariff and alternative tariffs for the now lower-energy demand and consumption. Another key factor in mitigating energy costs was to analyze and examine time-of-use (TOU) costs.

In order to help lower the initial capital costs of the project, the local, state, and federal incentive and rebate programs were tracked. These programs help to shorten the payback period and allow companies to more easily pursue energy-efficient upgrades. Nevada Energy can compensate up to 50% for certain types of equipment upgrades such as lighting retrofits, solar energy, mechanical retrofits, water conservation, variable frequency drives, energy management systems, window films, motors, and programmable thermostats.

SUMMARY AND CONCLUSIONS

Energy efficiency and renewable energy projects offer attractive risk-adjusted ways to increase current yields and property valuations and should be considered as one of several different capital investment options. These investments can save approximately 20 to 30% of a property's total annual operating expenses and do so in a safe and reliable manner that greatly increases the predictability of long-term operating budgets. ECMs should be implemented (or analyzed) first and in the proper loading order to determine the net effect on renewable energy-generation system sizes. Together, an energy conservation and generation project can reduce utility expense to near zero ROI, ranging from 10 to 30% or higher. The wide range of return has to do with the ability of the owner to benefit from all of the incentives, the type of facility, and the exact combination of solutions.

Energy projects offer an additional investment option with immediate and long-term cash flow savings. Often these projects turn overlooked fixtures and/or hidden common areas such as roofs into profit centers. The benefits that energy projects offer can vary widely and require a thorough engineering analysis to identify proper targets, accurately predict the savings, and deliver and construct the project to stand the test of time.

The key outcome from the case study was to determine the optimum package of energy conservation and generation measures to meet the owner's 15-year payback requirements, based on the following findings:

- The building baseline design already included some but not all LED light fixtures; and upgrading the remaining light systems to LED was also financially beneficial, with an approximate five-year payback.
- Changing the HVAC system design to a VRF solution from individual package units contributed to a 20%-plus decrease in energy costs. It also offered significant "soft" benefits in terms of occupant comfort and controllability. When maintenance savings were factored in with energy savings, the financial analysis indicated a payback of 14.8 years, and the hard and soft benefits combined to support this investment decision despite the high cost.
- Re-ducting the ERVs would save approximately 30% of the fan energy when compared to the current design; however, this item was not found to be cost-effective.
- Despite the relatively high electrical demand rates, the gas-powered heat pumps did not prove to be beneficial due to their relatively low efficiency when compared to electric heat pumps.
- Strategic insulation and glazing selection helped to reduce the building's peak cooling demand by almost 25%. This significant impact could allow equipment to be downsized, saving capital costs. Downsizing HVAC equipment tonnage had some perceived risks, primarily the inability for the cooling system to cope with the hottest days of the year in the event that the building energy model was incorrect. Ultimately, the concern and risks surrounding sufficient cooling capacity meant the HVAC equipment was not downsized. This, in turn, meant insulation upgrades were too expensive with too little energy savings and, at a 20-year payback, were not cost-effective.
- Power optimization was analyzed and had a very positive cost-benefit ratio, with a three-year payback. It was included in the recommended measures for implementation.
- Renewable energy technologies were cost-effective, with a combined payback of 9.5 years. Solar PV contributed a further 20% in energy savings, and financial analysis indicated it was accretive to the overall energy project, with a payback of less than eight years. By adding solar thermal, approximately 70% of the DHW annual energy was eliminated, and financial analysis indicated its payback was cost-effective, as well.

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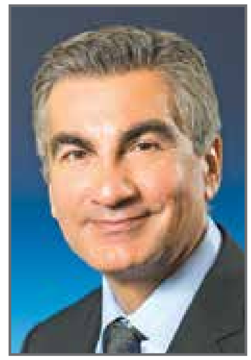
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New Silica Standards Could Cost Billions, Study Claims

A report by the Construction Industry Safety Coalition (CISC) found that the Occupational Safety and Health Administration's (OSHA's) proposed silica standards for the U.S. construction industry will cost the industry $5 billion per year—roughly $4.5 billion per year more than OSHA's estimates. The coalition of 25 construction trade associations (including the National Roofing Contractors Association, the Tile Roofing Institute, and the Association of the Wall and Ceiling Industry) cautioned that the flawed cost estimates reflect deeper flaws in the rule and urged the federal agency to reconsider its approach.

OSHA's proposed rule, intended to drastically reduce the permissible exposure limit (PEL) of crystalline silica for the construction industry, was estimated by the agency to cost the construction industry about $511 million a year.

"The cost and impact analysis from OSHA reflects a fundamental misunderstanding of the construction industry," a CISC statement reads. "The OSHA analysis included major errors and omissions that account for the large discrepancies with the CISC report."

The report estimates that about 80% of the cost ($3.9 billion/year) will be direct compliance expenditures by the industry such as additional equipment, labor, and record-keeping costs. The remaining 20% of the cost ($1.05 billion/year) will come in the form of increased prices that the industry will have to pay for construction materials and building products such as concrete block, glass, roofing shingles, and more. OSHA's estimates failed to take into account these additional costs to the construction industry that will result from the proposed standard.

The report also estimates the proposed regulation would reduce the number of jobs in the U.S. economy by more than 52,700. The full report can be found at www.nahb.org/silicareport.

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