SEDAC ENERGY SMART TIPS

Warehouses

At about 16% of commercial building space nationwide, warehouses represent a significant opportunity for improved operations, lower operational costs, reduced climate impact, and a more sustainable building stock through energy management. With rising energy prices, it makes good cost-effective business sense to apply proven energy conservation technologies in space conditioning, building construction, and illumination.

Warehouses are often only partially heated to prevent freezing, and they are rarely cooled. Occupancy and lighting requirements may be intermittent. According to the *Commercial Buildings Energy Consumption Survey,* the median warehouse size is 5,200 ft^2, 94 percent of the approximately 600,000 storage buildings fall into the "small warehouse" category (less than 50,000 ft^2), and only 2 percent of warehouses are refrigerated. The national annual average energy use intensity is 45 kBtu/sf.

Lighting and heating are priority targets for cost reduction (see pie chart on page 2). By adopting modern technologies for lighting, building envelope, heating and cooling systems, and refrigeration systems, warehouse owners can attain their energy-efficiency goals. Warehouse operators should also remember other environment-friendly habits, such as recycling and using recycled or "green" materials.

Whether you are building a new warehouse, designing an addition, or retrofitting an existing warehouse, the suggestions in this brochure can help you reduce your building's energy consumption. With a more efficient building, your business will make a greater profit and your employees will have a more comfortable work place. The Smart Energy Design Assistance Center (SEDAC) is committed to helping you reach your energy goals and improve your business' bottom line.

The Smart Energy Design Assistance Center performs energy assessments on various building types. Each building type has different energy requirements. SEDAC's Energy Smart Tips help building operators identify energy cost reduction measures.

HIGH FREQUENCY BATTERY CHARGERS

Forklifts are indispensable in today's warehouses, as are the battery chargers that power them. Battery chargers are an often overlooked energy-efficiency opportunity.

High frequency chargers (also known as switch mode, MOSFET or IGBT chargers) offer improved energy efficiency and are smaller and lighter than older types. In fact the gain in efficiencies is so great, it could be cost effective to replace battery chargers before they are due for replacement. A GP&E study found savings ranged from 2,900 to 4,800 kWh per year per charger for a three shift operation that used high frequency chargers for forklifts instead of the older charger types (study details at www.etcc-ca.com).

For incentives, check sedac.org

ENERGY STAR® 7 STEPS OF ENERGY MANAGEMENT

1. **Make a Commitment:** Recognize that the economic, environmental and political impacts of energy consumption are sufficient motivation to change our energy use patterns.
2. **Assess Performance:** Make a personalized accounting of energy use and costs. Benchmark your facility by comparing its energy performance with similar sites.
3. **Set Goals:** Review your objectives and constraints. Establish priorities and set measurable goals with target dates.
4. **Create an Action Plan:** Define the technical steps. Apply proven methods to increase energy efficiency or get specialized guidance. Assign roles and resources. Consider rolling savings from earlier efforts into future, more complex initiatives.
5. **Implement Action Plan:** Install equipment and change operational procedures. Establish a maintenance schedule. Train equipment operators and building occupants on the changes. Track and monitor conditions.
6. **Evaluate Progress:** Compare current performance to established goals. Understand what worked well in order to identify best practices. Adjust procedures, goals, and schedule the next evaluation.

ENERGY STAR's steps for energy management. Descriptions have been modified by SEDAC staff.

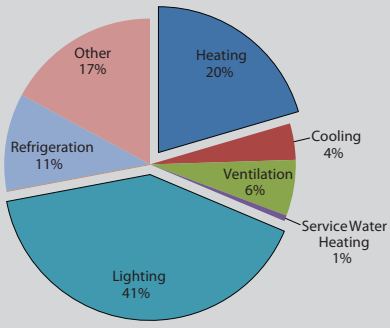
7. **Recognize Achievements:** Provide internal recognition for the efforts and achievement of individuals, teams, and facilities. Seek external recognition from government agencies, media, or third party organizations.

STEPS TO REDUCE ENERGY USE & COST OF LIGHTING IN WAREHOUSES

At 41 percent, lighting accounts for the biggest energy cost in a warehouse. Efficient lamps, fixtures, and controls save money and improve working conditions. By adopting these energy-saving steps, lighting energy can be reduced by up to 50 percent.

LPD check: compare the existing or planned lighting power density (W/sf) of the space with the maximum recommendations of the *Advanced Energy Design Guide for Small Warehouses*. For bulky or self storage areas limit lighting to 0.6W/sf, for fine storage 0.85W/sf, and for office areas 0.9W/sf.

Linear fluorescent: choose T5 or Super T8 linear fluorescent fixtures in place of metal halide options to use less energy for the same amount of light and better color rendering, in addition to uniform light distribution (down the aisles), instant-on and restrike, and compatibility with multiple lighting control options. Specify premium efficiency ballasts. If reduced wattage T8 lighting is installed (e.g. 28W or 25W for a 4' lamp) verify that lamps have adequately low start temperatures and compatibility with desired control options such as occupancy sensors. T12 fluorescents should be replaced with super T8s for rapid return on investment.



National Average Utility Cost Breakdown
(Using $0.10/kWh electricity and $1/therm natural gas)

Pulse start metal halide: if metal halide lamps are preferred over linear fluorescent for lamp size or partial upward light requirements, choose pulse start lamps in place of standard probe start lamps. Since metal halide and other high intensity discharge lamps have a relatively long warm up time, on-off switching with occupancy sensors is not appropriate. Instead look for electronic ballasts with step-level switching or dimming capability to reduce lighting loads during lull periods.

LED exits: use LED lamps for exit signs. At 1.5W/lamp, LEDs use a small fraction (1/10th or less) of the energy required for compact fluorescent or incandescent lamps and last at least 10 years, which saves on maintenance requirements.

Lighting controls: use lighting control strategies such as scheduling, occupancy sensors, daylight harvesting, bi-level switching, and dimming to turn lights off or down when not needed.

Outdoor lighting: install photo-sensors to automatically activate lamps when daylight diminishes, and place motion sensors in lesser-used areas.

Daylighting: consider using skylights, north facing clerestory windows, or south facing windows with overhangs to make use of natural lighting (see page 4 for details).

Routine maintenance: clean and replace lamps on a fixed schedule to avoid dirt and dust build-up and ensure full-light output.

ENERGY TIPS TO IMPROVE THE BUILDING ENVELOPE IN WAREHOUSES

Roof and Wall Insulation: verify that wall and roof insulation levels meet the guidelines for your climate zone and building operating conditions in the *Advanced Energy Design Guide for Small Warehouses*. Be sure to add needed insulation when renovating the interior or the roof of the building as incremental costs are lowest at these times.

Cool Roof: for cooled spaces consider a cool roof with a special coating that reflects solar radiation and reduces surface heating. Cool roofs are especially beneficial in cities to reduce the heat-island effect.

Roof Openings: remove unused equipment from rooftop, cap off openings, and add insulation.

Windows: choose multiple pane windows with a U-value (rate of heat loss) less than or equal to 0.3, low **Dock Seals:** use brush type seals for dock levelers and inflatable or foam-type

hinge seals for dock doors to minimize infiltration. For best results, use dock shelters which enclose the rear of the truck to reduce outdoor air exchange.

Doors: install insulated doors to reduce conduction losses.

Partition Walls: insulate interior partition walls between semi-heated and conditioned spaces.

Sealant: replace worn weather-stripping and caulking to ensure windows and doors are airtight. Also air seal building seams and joints (tops and bottom of walls, around windows, etc.) and penetrations (electrical wires and conduit, plumbing, flue or HVAC ducts, etc.) with site appropriate sealing material (tape, caulk, weather stripping, grout, foam, etc.) to create a continuous air barrier around conditioned space.

Passive solar design: during the architectural design phase for a new building, consider a rectangular floor plan that is elongated on east-west axis, glazed south wall, thermal storage media exposed to the solar radiation which penetrates the south-facing glazing, and overhangs.

HEATING, VENTILATION, & AIR CONDITIONING

Transpired Walls: for new or retrofit construction, use south-facing transpired solar walls. These walls take in outside air and pass it through solar collectors to pre-heat the air to 30-55ºF. These walls reduce the building's heating load, improve indoor air quality, and are especially applicable to spaces with high ventilation requirements (for more information visit www.nrel.gov/docs/fy01osti/30176.pdf and solarwall.com/en/home.php)

Efficient Furnaces and Air Conditioners: choose high efficiency condensing furnaces and unit heaters (92+ efficiency) and high efficiency air conditioners (EER 11.5+ for larger units, SEER 14+ for smaller units). Note that non-condensing outdoor furnaces (e.g. in rooftop units) are only 80% efficient, so consider locating a condensing furnace inside the building, such as suspended from the ceiling, to accommodate the best efficiency equipment.

HVAC Controls: vary space conditioning temperatures and ventilation rates in accordance with occupancy patterns, building activities, and the needs of the stored goods. Use programmable thermostats with timeclocks, setbacks, and demand control ventilation to reduce energy requirements. Installing internet thermostats on remote unit heaters will allow for monitoring and control of multiple units that sometimes get left in the heating position even during the summer. Divide the building into thermal zones with separate controls based on space function.

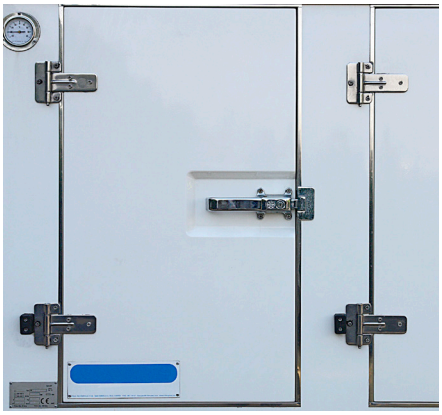
Radiant Heaters: consider radiant heaters to heat the building occupants instead of the air. Space temperatures can be kept lower than with forced air convection furnaces. They may be particularly effective near loading dock doors.

Air Destratification: in high bay spaces with heaters located near the ceiling, use ceiling mounted fans or high velocity diffusers to move hot air to the floor level during the heating season.

Natural Ventilation: utilize operable clerestory windows or skylights to allow hot air to escape during warmer weather.

Heat Recovery: capture exhaust heat from mechanical equipment to augment space heating.

REFRIGERATION TIPS



Walk-Ins: if walk-in refrigerators and freezers have standard efficiency shaded pole motors on evaporator fans, replace with Electrically Commutated Motors (EMC).

Refrigeration Control: verify with your refrigeration technician that your system has employed the most efficient control strategies including floating head pressure (which varies compressor head pressure based on outdoor conditions), intermittent evaporator fan control (instead of constant), demand defrost cycles (instead of timeclocks).

Heat Recovery: investigate options for heat recovery from the condenser coils to heat domestic hot water.

GREEN TIPS

- ✓ To keep the building cooler in the summer, reduce the amount of paving around the warehouse, and landscape the site to provide shading for both the building and the remaining paved areas.
- ✓ Use battery-powered or fuel cell forklifts to reduce air pollution. These forklifts reduce ventilation loads since they do not exhaust fumes into the space and their batteries can be recycled.
- ✓ Choose building materials that are manufactured within a 500-mile radius or use recycled materials (steel, wood).

SAVE ENERGY WITH SKYLIGHTING IN WAREHOUSES

As previously discussed, interior lighting plays one of the biggest roles when it comes to energy consumption in warehouses. Skylights are an energy-efficient and cost-effective way to light warehouses.

By using diffused natural light, energy and maintenance costs can be significantly reduced during the day. Skylights provide a more distributed light and reduce shadowy surfaces normally created by lights from lamps. They have also been shown to increase productivity and improve employee morale in the warehouse.

For the most effective skylights, space skylights no more than 1.5 times the ceiling height and use a glazing material that diffuses the light to avoid glare. Also install an automatic photocontrol system that adjusts electric lights depending on the availability of daylighting. For maximum lighting and light reflectance, paint the ceiling and structural elements of the warehouse white.

For more tips on skylighting in warehouses, read the pamphlet "Warehouse Skylighting Know How" at www.designlights.org.

ENERGY SMART RESOURCES FOR WAREHOUSES

Forklift Options
Learn about the benefits of fuel cells and other power options for forklifts.
http://www.ipd.anl.gov/anlpubs/2008/11/62912.pdf

Cool Roof Rating Council
Learn about the benefits of cool roof systems.
www.coolroofs.org/

Efficient Windows Collaborative
Find out what kind of window is most appropriate for your warehouse.
www.efficientwindows.org/

Whole Building Design Guide
Learn about integrated "Whole Building" design technologies.
www.wbdg.org/design/warehouse.php

Advanced Energy Design Guide
Download a free copy of the *Advanced Energy Guide to Small Warehouses and Self-Storage Buildings*.
www.ashrae.org/publications/page/1604

Dock Seals and Shelters
Read about impact on energy use.
http://www.ameren.com/sites/aea/LearningCenter/Pages/LoadingDockShelters.aspx

Warehousing Education and Research Council
Read articles on different ways to save energy in warehouses.
http://www.werc.org/learningcenter/learning_materials.aspx

SEDAC

WHO WE ARE

SEDAC is sponsored by the Illinois Department of Commerce and Economic Opportunity in partnership with investor-owned utilities to achieve energy efficiency savings in buildings throughout the State of Illinois.

SEDAC is an applied research program at the University of Illinois at Urbana-Champaign.

SEDAC works in` collaboration with the 360 Energy Group and the Energy Resources Center at the University of Illinois at Chicago.

SEDAC PROGRAMS

- Energy Assessment
- Public Sector Retro-Commissioning
- New Construction Design Assistance
- Public Sector New Construction Incentive Review
- Public Housing Efficient Living
- Training and Outreach
- Energy Incentive Guidance

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