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GREENHOUSE SYSTEMS
SYSTEM 420 HYBRID GREENHOUSES

White Paper

Energy Efficiency in Cannabis Growing

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Background

Energy efficiency in a cannabis greenhouse is a result of many varied functions. Similar to a home, there are extensive maintenance tasks, which if consistently implemented, can significantly reduce energy consumption as well as utility bills. Beyond maintenance, there are design and growing system components that also contribute to lower consumption patterns. When all of these areas are combined, then the cumulative impact can be substantial.

With a System 420™ hybrid greenhouse from Nexus, the grower can receive the privacy benefits of the indoor grow and the modern agricultural practices of the greenhouse. Cannabis crop efficiency, reduced operating costs, natural sunlight, and a healthier work atmosphere can be achieved in a hybrid greenhouse growing environment.

As a greenhouse manufacturer, Nexus designs high quality, commercial greenhouses for the traditional horticulture and the emerging cannabis markets. The company partners with supplemental equipment providers, and manages integrated greenhouse development. This white paper outlines several items to consider for increasing cannabis greenhouse energy efficiency.

Key Statistics

- Outside of licensing fees, energy ranks as one of the top expenses for marijuana cultivators in many states – in some cases hitting $10,000 or more a month for large growing operations

  http://mjbizdaily.com/zapped-by-escalating-energy-costs-marijuana-growers-seek-alternatives/

- Heating energy represents 70% to 80% of a greenhouse grower's total energy consumption

  https://articles.extension.org/sites/default/files/2.%20A3907-01.pdf

With this level of costs, developing an efficiency plan may determine whether a cannabis company financially survives. The days of easy money in the cannabis industry are nearing a close. Falling prices, oversupply, and rising utility costs are contributing to a tighter financial model. Reducing utility bills are about more than increasing profit. Energy efficiency may determine business survival.

Structure Types

Gutter-connected cannabis greenhouses, which cover one-half of an acre (21,780 sq. ft.) have 10% to 15% less surface area and a lower amount of heat loss than most stand-alone greenhouses, which cover the same area. Stand-alone greenhouses have a surface area-to-floor area ratio of approximately 1.6 and gutter-connected greenhouses have a ratio of less than 1.4.

A comparison of two greenhouse systems with 24,000 sq. ft. of floor space brings intriguing results. Each operation features LP gas power-vented unit heaters with a seasonal efficiency of 78%.

- **Grower #1** has eight 30 x 100 ft. greenhouses with 3-ft. sidewalls and 15-ft. peaks

- **Grower #2** has one five-bay gutter-connected 150 x 160 ft. greenhouse (30 ft. wide bays) with 10 ft. sidewalls and a 15 ft. peak

Grower #1 (stand-alone) will use 14,344 gallons of fuel and Grower #2 (gutter-connected) will use 11,929 gallons. Thus, the gutter-connected greenhouse will consume 2,415 less gallons for a 17% energy savings.

Roof & Wall Coverings

A fundamental method for efficient greenhouse heating is to assess the specific structure. Energy losses vary depending on the greenhouse covering and the structural age. Overall, newer structures will have better seals around the coverings and openings than older houses.

Double-layer coverings including acrylic, polycarbonate, polyethylene transmit light quite well and retain heat better than single-layer glass or single-layer polyethylene. Rigid materials (acrylics and polycarbonates) can be more expensive, yet are often worth the cost due to the durability and energy savings. These double-layer coverings usually use 50% less energy that single-layer coverings.

Polycarbonate structured sheets, either in multi-wall or corrugated configurations, are common in the cannabis market. The multi-wall sheets give the user additional energy savings over single wall polycarbonate, while the single wall covering will have a higher light transmission for the plant. Both types of sheets can be manufactured with light diffusing abilities. Understanding cannabis crop needs based upon light, heat, humidity and geographic environmental factors will help determine the best covering selections for each greenhouse operation.

Insulation

Cannabis greenhouse walls, which face north let in a smaller amount of light than the other walls, especially in the winter months. Insulation can be added to the north walls to reduce heat losses. If the walls have a white surface, light levels will be enhanced by reflecting winter sunlight that would have passed through the north wall. Using insulation between the metal side-walls and around heat plumbing provides significant energy savings. The addition of light deprivation or energy shade curtains is one of the most effective ways to conserve energy. This effort can reduce nighttime heat loss by about 50%.

Another cannabis greenhouse area where heat is lost is along the inside perimeter through the greenhouse ground and sidewall portions. Insulated boards that run from the bench height to slightly below the ground level contribute to about a 5% energy savings. Light deprivation curtains also contribute to energy efficiency by retaining heat during the night or blackout hours.

Heating

Cannabis greenhouse heating energy efficiency involves the type of heating system, location, and maintenance. Unit heaters are popular in greenhouses due to low capital and installation costs, dependability, and staging ease. Multiple heaters are highly recommended to reduce the potential for total heat loss from equipment failure. In larger greenhouses, a central hot water

boiler is a common choice. Heat is distributed through heated floors, radiant heat pipes, or water-to-air heat exchangers. An efficient boiler with consistent maintenance will keep energy costs at reasonable levels.

A productive heat distribution location can lower energy consumption while increasing plant growth and yields. Cannabis greenhouses frequently use one or two forced-air unit heaters that distribute air above the plant height level. When two unit heaters are used, then placement usually occurs in opposite corners on opposite ends of the greenhouse to create circular airflow. Heaters are often placed at elevated heights to allow more room for benching systems. Since heat rises, the entire greenhouse must be heated to maintain the desired temperature at the crop level.

Distributing heat from the floor, under benches, or bench-tops creates a growing climate that warms the plants and adjacent areas, yet does not heat up the entire greenhouse. Known as root-zone heating, this cannabis crop production method provides additional energy savings.

Forced Air Overhead Unit Heaters

Horizontal Air Flow (HAF) Fans

Reducing air leaks and heat loss makes a cannabis greenhouse tighter. Regardless of the heating system type used, placing a sufficient number of HAF fans to adequately circulate air inside the greenhouse will increase energy efficiency. Solid air circulation will improve greenhouse temperature and humidity consistency, which reduces the number of cold pockets and improves plant quality and uniformity. Keeping the humidity level below 80% by venting, when necessary, minimizes disease incidence.

Air circulation by the HAF fans should consist of two to three cu. ft. per min. over the greenhouse floor surface. A 28-ft. x 96-ft. greenhouse needs an airflow of 5,376 cu. ft. per min. (28 x 96 x 2 cu. ft. per min. per sq. ft. = 5,376 cu. ft. per min.). This cannabis greenhouse structure would require four HAF fans with a capacity of circulating air at 1,440 cu. ft. per min. HAF fans usually operate at two different speeds. Be sure to check the fan specifications to determine the necessary speed. These fans should be situated two to three feet above the plant

height level and aligned parallel to the greenhouse sidewalls so that air can flow in a circular pattern. Winter operation is recommended to improve temperature and humidity levels.

Supplemental Lighting

The use of supplemental lighting allows the cannabis grower to accomplish the following:

- Provide extra light on cloudy and low natural light days (winter, northern latitudes)
- Different growing environments require a varied amount of accumulated light
- Maintain consistent light levels during the year

High intensity discharge (HID) lights are mainly used in greenhouses, which consist of two types. These types are high pressure sodium and metal halide fixtures.

To decrease energy consumption, timers or light integral controls can be used. These types of controller measure the sunlight that enters the greenhouse on a daily basis and regulates the lights to ensure ample light reaches a minimum daily light integral, which determines plant growth.

LED

LED lighting technology is presently on the market and under testing in a wide range of scenarios. These lights are currently most effective in small batches where a modest number of lighting fixtures can enhance growth on a limited number of plants in concentrated areas. On a larger scale, more research needs to occur to justify the light fixture costs. The future potential for these lights is significant, yet wide-scale distribution will not occur until there is greater product quality consistency and more cost-effective prices.

Light Transmitting Coverings & Light Deprivation

The greatest benefit of a cannabis greenhouse is the energy saved by using the free light of the sun. Greenhouses are covered by light transmitting coverings, which allow in 80% to 90% of the available sunlight. The differences in light transmission are due to the variety of coverings used on the greenhouse roof and sidewalls. These coverings reduce the necessary amount of artificial and supplemental lighting that decrease overall energy consumption.

Light deprivation is a technique of altering the light cycle of flowering plants. These systems utilize the power of natural sunlight, an abundant source of free energy. Cannabis greenhouses use blackout curtains to block light and deny the crop an extended photoperiod.

A light deprivation system inside a cannabis greenhouse can reduce heating costs by at least 50%. The use of sunlight decreases the role of artificial lighting, which is a large part of the utility cost structure. As a result, greenhouses have increased overall energy efficiency. According to curtain manufacturer, Ludvig Svensson, the utility costs within a greenhouse are 50-75% lower than in an indoor warehouse growing environment.

The blackout curtains underneath the roof coverings and along the sidewalls help retain heat during the dark periods. Heat is retained in the growing area without losing heat energy through the roof. This process needs to be carefully managed to prevent extreme heat buildup, which can damage plants.

Blackout curtains as a part of a hybrid heat-saving curtain

Environmental Controls

There are many greenhouse environmental factors that need to be managed, especially air temperature, humidity, CO2 levels, lighting, and irrigation. To better control energy costs, several interactions need to be avoided. These interactions include running exhaust fans when the heater is on, cycling heaters and fans on and off, and operating fans while adding CO2. With manual controls, some interactions cannot be avoided. However, with a central controller, the control system can be optimized to prevent unnecessary conflicts.

A basic controller usually manages heaters and fans to permit the heater to have day and night set points. If the greenhouse fans are staged, a basic controller may also increase the number of operating fans as internal greenhouse temperatures rise. Sophisticated controllers may have outputs to control heaters, fans, louvers, CO2 enrichment lights, thermal or shade curtains, or irrigation, as well as inputs for temperatures, humidity, CO2 levels, daily light integrals, soil moisture, and a weather station. Proper measurement methods are vital to obtaining accurate temperature readings.

Whether using a mechanical thermostat or a sophisticated computer system, a regular tune-up is essential. An inspection by an environmental controls company with specialized knowledge may be necessary. However, any greenhouse manager can perform basic checks. For example, if the ventilation fans are running while the heat is on, then there is a concern.

Maintenance

Consistent maintenance is the most fundamental way to increase energy efficiency. Many tasks are surprisingly simple and cost-effective. By tightening up the cannabis greenhouse, a substantial impact can be made. Over time, greenhouse structures develop holes, cracks, and openings in the walls or roof, which permits the cold air to enter and the warm air to leak out. Fixing these leaks can be made with a can of spray foam and a tube of caulk. Tightening up the greenhouse also improves airflow patterns that contribute to more uniform temperatures and humidity levels. This effort can reduce heating bills by 5% to 10%.

Accumulating dust on greenhouse blades, louvers, and safety screens may increase energy usage by as much as 20%. A rag and cleaner solvent can correct this issue. When cleaning, check for any broken fan blades. Bent or malfunctioning louvers as well as drilled holes or gaps around the fan housing may be evident. These louver problems can contribute to higher winter heating bills. Malfunctioning louvers need repair and any holes or cracks should be covered up.

Heating maintenance is also crucial to cannabis greenhouse operations to prevent crop loss or inefficient energy costs. Inspecting the heaters on an annual basis will usually cover the maintenance costs in fuel savings and reduce emergency service calls. Heat exchangers and burners, need to be inspected and cleaned annually. In addition, the thermostats require calibration. Soot on boiler heat exchangers or fire tubes can raise energy consumption by 10%. With a central heating system, insulating pipes and ductwork is beneficial. Overall, proper heating system maintenance can decrease energy costs up to 20%.

View of greenhouse structure and equipment to show need for maintenance

About Nexus

Nexus Corporation has served the greenhouse industry as a top US manufacturer since 1967. With a corporate office and production facility in Northglenn, CO along with an advanced manufacturing plant in Pana, IL, the company brings innovative designs, high quality products, and exceptional customer service to its System 420™ hybrid greenhouse systems.

Nexus has a team of engineers (licensed in 49 states), sales, project management, customer service, and operations professionals dedicated to managing a greenhouse development project from start to finish. The team has expertise regarding the customized design components, efficiency features, and cost management strategies necessary to maximize crop yields and return-on-investment.

For more information on greenhouses from Nexus Corporation, click here.

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