

WHITE PAPER

COMPONENTS OF A MARIJUANA GREENHOUSE

OUR APPROACH

The marijuana industry is becoming more competitive and prices are falling. Growers must carefully manage their costs to ensure economic viability. With an increasing number of growers moving to greenhouses, those who remain as indoor growers will feel financial pressure as they pay utility bills that can be up to four times higher for a similar size greenhouse growing space. In other industries, companies that do not cut costs to remain competitive can find themselves out of business.

Addressing security is an effort that involves using traditional greenhouse techniques and making modifications to fit the needs of today's marijuana growers. The main ways to modify traditional greenhouses involve the external structure. Using metal sidewalls provides the security and privacy sought by many growers who do not want their crops viewed by competitors or the public. This security extends to the roofs, as greenhouse coverings with light-deprivation curtains also prevent visual access.

With a secure facility, the grower can focus on producing the best possible crops in a natural growing environment using modern agricultural practices instead of simulating growing under artificial conditions. The sections below describe the key components that Prospiant uses to construct cost-effective and efficient marijuana greenhouses.

GREENHOUSE STRUCTURES

Galvanized Steel

Greenhouses are typically made with galvanized steel. The material has a proven track record of a long life. It is an economical construction material for a greenhouse. This type of steel has undergone chemical processing to make it corrosion-resistant. Steel is coated with layers of zinc that provide a surface to protect the metal from rusting and produces a more durable, low maintenance, scratch-free finish with an economical cost and a long life.

The most common method is hot-dipped galvanization. Galvanized steel is created by submerging the steel into melted zinc. This process allows the zinc to permanently bond to the metal, not only on the surface, yet within the actual steel, to form a secure and complete bond.

Prefabrication

Prefabrication is the practice of producing components in a manufacturing facility and transporting complete assemblies to the greenhouse construction site where the structure is to be built. This method saves time and costs, since similar construction tasks can be grouped and manufactured. Prefabrication avoids the need to transport so many skilled workers to the construction site, where other restricting conditions, such as a lack of power or water, and weather exposure are avoided. Benefits of prefabrication include:

- Factory-made materials
- Shorter construction time

- Less exposure to adverse weather
- More cost-effective use of resources
- Increased construction quality

Trusses

A major component of prefabrication is the trusses. These greenhouses use pre-manufactured trusses to support the roof. Prefabricated trusses are built in a manufacturing facility and are carefully designed to carry the load of a roof to the outside walls. The primary benefits of using prefabricated trusses are cost savings, construction speed, consistency and strength.

While the basic advantages are mentioned above, additional advantages of roof trusses in building greenhouses include:

- The use of professional design and fabrication techniques. A trussed roof system is designed by engineers to accommodate the specific roof design and meet building codes to enable more uniform sizes and roof pitches.
- Roof trusses span much longer distances without the need for load-bearing interior walls.

Roof Coverings

Standard greenhouse coverings are high light transmitting materials. The use of natural light through these coverings is a tremendous cost savings versus indoor growing facilities and their use of high-intensity growing lights. In addition, greenhouse coverings have various characteristics that enhance the growing environment. For example, some coverings will diffuse the light by giving a more uniform and deeper light penetration.

Polycarbonate structured sheets, either in multi-wall or corrugated configurations, are common in the cannabis market. The multi-wall sheets give the user 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.

The use of metal and insulation in the walls increases energy savings, lowers operating costs, and improves the overall growing environment. This covering is particularly advantageous in the roof and walls for the work areas of the operation.

Glass is a traditional greenhouse covering that is still used in today's market. Current glass products allow for wider bar spacing, yet still withstand required snow and wind loading. The styles of glass used include tempered and laminated. Glass attributes are high light transmission and longevity. Glass, as a single-layer covering, has higher energy costs and heat gain that can be partially offset with energy curtain systems.

Security Siding

By growing cannabis in a greenhouse, there are often concerns about security. With traditional glass or polycarbonate sidewalls, visibility from the outside, theft and the loss of confidential growing practices are at risk. To remedy this situation, hybrid greenhouses have insulated metal sidewalls to add a solid layer of extra security. When growers choose not to have outdoor signage, then the internal contents of the greenhouse will remain unknown. From an outside perspective, observers will simply see industrial building structures.

The addition of insulation provides further energy consumption savings. Metal siding is also part of the light deprivation system. Traditional greenhouse coverings need to be covered during dark photoperiod time frames. These systems provide an added cost and will need to have maintenance. There is an added benefit of the interior metal reflecting light back to the crop.

Insect Exclusion

Growing cannabis in an organic environment without the use of pesticides and fungicides is important for consumer health. Unless protected, greenhouses are at risk for an infestation from the outside environment. To reduce the use of chemical insecticides and pesticides, screening is the most effective and economical strategy available.

While screening does not guarantee a complete pest-free greenhouse, it makes a major difference. Using screens over greenhouse vent inlets can be tricky due to airflow requirements inside the greenhouse. Screens create resistance, which reduce airflow and affect the operation of the cooling/ventilation system. When the mesh openings in the screen are larger, there is less resistance. Appropriately matching the mesh type to the pests you are trying to exclude is important. Maximizing the screen hole size allows the ventilation system to work more efficiently. The greenhouse design team needs to consider these factors when properly designing the ventilation equipment.

GREENHOUSE EQUIPMENT

Cooling

Greenhouse ventilation is one of the biggest influences in maintaining an ideal climate for cannabis cultivation. A reliable ventilation method in many areas is a fan and pad mechanical system. Traditional fan and pad systems are still common in areas that have temperatures and humidity, which are conducive to evaporative cooling.

These systems will exhaust the hot greenhouse air through fans and provide a cooler environment by pulling air through a wet wall and lowering the outside air temperatures. The wet wall is covered by a motorized vent or shutters. The ventilation process involves horizontal air flow moving throughout the greenhouse from the evaporative pads to the exhaust fans. Fan cooling produces air flow through and around the plants, which reduces disease and assists in the growing process.

Natural ventilation allows for an inexpensive method of cooling. With the use of roof vents, the clear opening to the sky quickly allows the hot air to escape, similar to a chimney. Side inlet vents and shade curtains lead to temperatures, which are lower than outside temperatures. Natural ventilation may not maintain the required temperatures for good plant growth during the hottest times of the year.

Positive pressure cooling (an alternative to fan and pad cooling) pushes air through an evaporative cooling system, which forces the air into the greenhouse. Exhaust vents must be designed to allow air pressure to stabilize while still creating higher air pressure inside the greenhouse than outside. Due to this internal air pressure, insect infiltration through greenhouse openings is further restricted.

Heating

One traditional method to heat greenhouses is with overhead gas-fired heaters, which blow hot air into the greenhouse environment. The heated air is then mixed throughout the greenhouse by use of horizontal air flow (HAF) fans to circulate heat to the needed areas within the greenhouse. These heaters are highly efficient, considering the inexpensive capital cost, ease of installation and long product life.

Hot water radiant heat can be used in combination with an overhead heating system or as a stand-alone system. This efficient hot water system places the heat closer to the plant through piping under the benches or imbedded in the greenhouse floor. The proximity of this system's heat distribution to the plant helps in plant growth and uniformity and decreases humidity at plant levels, which reduces disease. These systems will have higher capital costs, yet provide a payback with money saved through operational costs. If the greenhouse area is broken up into multiple zones, the system can be designed to accommodate different environments for various crops for greater efficiency.

Environmental Control

Effective climate control is a crucial step toward producing any greenhouse crop, particularly cannabis. The environmental climate control system's design needs to consider outside conditions to create the best possible inside environment for plant growth. Greenhouse ventilation is the factor with the most influence on climate control.



Controlling the internal greenhouse climate is usually highly automated. Sensors will monitor various conditions, such as temperature and humidity, which trigger mechanical systems to bring those conditions to a setpoint. For example, if a greenhouse gets too warm, motorized windows or vents will open in combination with exhaust fans to expel the hot air.

Environmental control systems can be simple thermostats or sophisticated computer controls. By setting parameters, efficient cycling of equipment

through various stages can achieve the desired environment. Specific controls run ventilation equipment, watering systems or alarm warnings to correct problems in single or multiple zones. Owners should contact local utility companies regarding rebate programs to help pay for control systems to reduce energy usage.



Supplemental Lighting

One of the major benefits of cannabis production in a greenhouse versus indoor growing is the collective ability to capture and utilize Mother Nature's gift of sunlight.

Greenhouse cannabis production maximizes the available natural light for plant production and reduces capital as well as operating costs of lights required for indoor growing.

For various reasons throughout the year, supplemental lighting is needed in a greenhouse. A few of these reasons include:

1. Supplement cloudy and lower natural light days (winter, northern latitudes)
2. Separate growing environments require a varying degree of accumulated light
3. Guarantee consistent light levels throughout the year

Typical lights used in a greenhouse are high-pressure sodium and metal halide fixtures.

LED lighting technology is currently used and tested in a variety of ways. This lighting is presently most effective on a smaller scale, where a few fixtures enhance growth on a large quantity of smaller concentrated plant areas. For large-scale use, the experimentation continues. Fixture costs are still too high to be offset by plant benefit and operating costs. Future advances in technology may make this method of lighting comparable to more traditional lighting methods with the potential to outperform those methods.

Light Deprivation

With the emerging popularity of cannabis growing, the use of light-deprivation techniques for marijuana greenhouses has become commonplace. These methods have been an important part of other agricultural practices for hundreds of years. Light deprivation decreases the light cycle of plants and induces flowering.

For cannabis growers, this process is vital to keeping plants in the flowering stage. When the photo period exceeds 12 hours, cannabis plants will not flower and will remain in their vegetative stage. Inducing flowering through light deprivation is a vital process in the cultivation of cannabis, and growers rely upon this process and equipment to ensure timely crops.

A light-deprivation system features retractable black-out curtains, metal side and end walls, and light traps/breathable walls over motorized inlet shutters and exhaust fans or evaporative coolers. This system produces adequate horizontal air flow while creating a dark environment for the plant.

To cover a greenhouse and block out the sunlight, several light-deprivation methods may be implemented. For smaller greenhouses, including lean-tos and cold frames, growers can pull heavy tarps over the structure. With larger commercial greenhouses, automation with programmable timers is the best option. Automation also reduces human error in any size greenhouse.

Benching

The use of greenhouse benches has several advantages over planting directly into greenhouse soil or setting pots on the ground:

1. Increases growing space by eliminating aisles
2. Convenient heights to work comfortably
3. Permits a more effective display of plants
4. Improves air circulation and environmental controls
5. Contributes to better disease and growth management

Benches use a steel or aluminum perimeter rail along with steel cross tubing for a strong top and leg system. These benches are either stationary or use a rolling bench top. The rolling bench contains a single floating aisle to allow for more bench square footage inside the greenhouse. These benches are strong and durable enough for heavy potted crops. Bench tops can be covered with different coverings, depending on owner preferences.

Palletized rolling benches (often called Dutch trays) are useful in large growing operations when benches can take the place of a material handling system. Individual bench tops move along supports in dual directions (perpendicular and parallel) to the legs from the head house to the greenhouse and back to the head house for shipping. These systems increase efficiency and decrease labor costs.

CONCLUSION

Cultivating marijuana in a greenhouse is a serious endeavor. By equipping a hybrid greenhouse with a customized array of equipment and covering, growing operations can produce higher-quality crops, increase crop yields, reduce or eliminate the use of chemical fungicides and pesticides, better manage costs, and significantly improve overall efficiency over an indoor growing facility.

With the overall indoor marijuana industry consuming 1 to 2% of national energy resources, utility companies are enacting policy changes to penalize high-volume energy users. As more states legalize both recreational and medical marijuana in the years ahead, surcharges for high energy consumption will significantly increase. Greenhouse growing provides the opportunity to substantially reduce energy bills by lowering consumption patterns and moving into lower rate tiers while providing an environment conducive to growing high-quality and profitable crops.

ABOUT PROSPIANT

As individual brands, our companies are seen as trusted advisers because we share our deep, practical expertise and our collective experience of more than 185 years in controlled environment agriculture (CEA) businesses. Now combined as Prospiant, a Gibraltar Industries company, we draw upon our fertile heritage to provide powerful end-to-end solutions that meet the unique needs of customers who grow and process cannabis and non-cannabis agricultural products.

From plant to product, we work alongside our customers. We listen to their challenges and respond with agility, attention and care because we measure our success by how much we contribute to the growth of our customers' businesses. That's what strong partners do. Our smarts, savvy, technologies and strategic thinking stand upon the foundation of our rigorously vetted, well-managed portfolio of industry-leading growing and processing companies in the next decade's most consequential growth sectors. Our brands and solutions include:

- **Apeks Supercritical** manufactures CO₂ extraction equipment for the safe and efficient extraction of high-quality oil from plant-based biomass such as hemp and cannabis.
- **Delta Separations** manufactures solventless and solvent-based ethanol extraction equipment for the safe extraction and distillation of high-quality oil from plant-based biomass such as hemp and cannabis.
- **Nexus Greenhouse Systems** is your single-source solution for commercial, cannabis and institutional greenhouse design, engineering and manufacturing.
- **RBI (Rough Bros, Inc.)** is your expert partner for the design, manufacture and build of commercial and institutional greenhouses for agricultural and horticultural growing environments.
- **Tetra** designs and builds automated indoor cannabis cultivation facilities and systems to deliver absolute growing precision through automation integration.
- **ThermoEnergy Solutions, Inc.** is your trusted partner for engineering, fabrication and installation of large-scale complete commercial greenhouse turnkey projects.