



White Paper

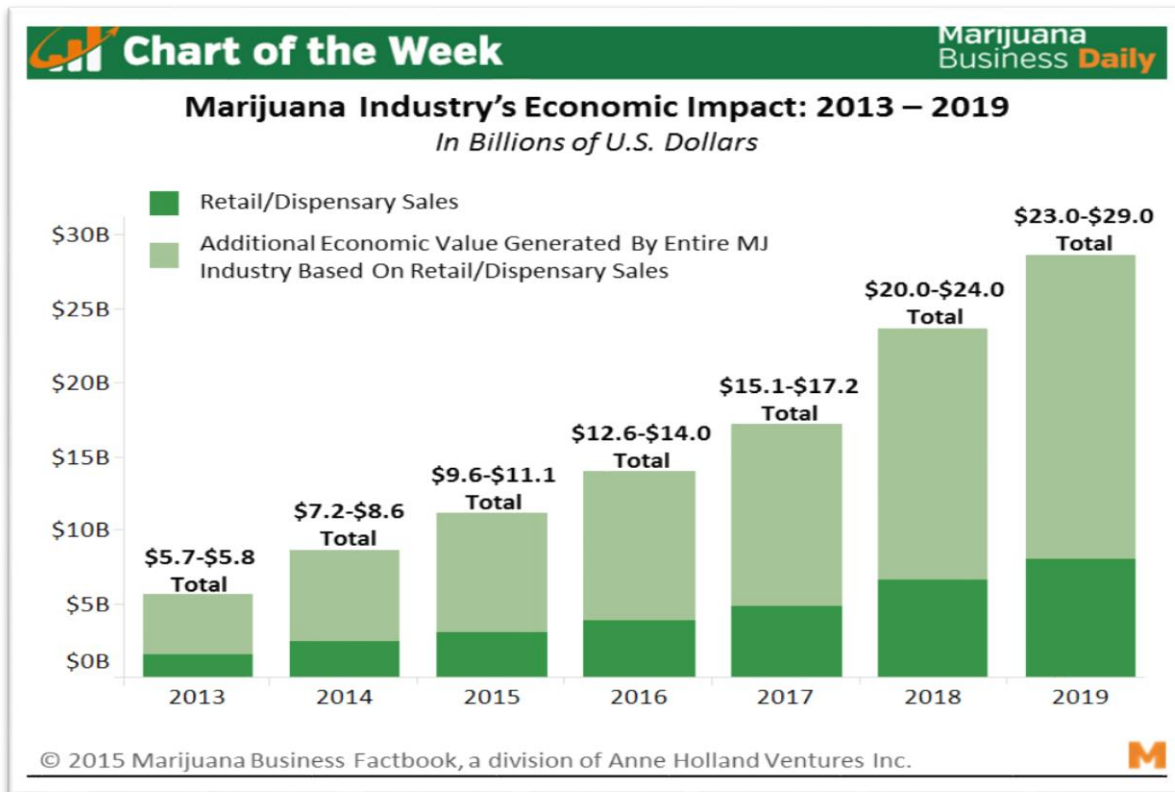
Components of a Marijuana Greenhouse

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The Issue

The marijuana industry is rapidly evolving. Legalization in US states, intense industry price competition, and high utility costs have forced many cannabis growers to question the financial model of indoor warehouse growing. As prices fall due to a strong supply of marijuana product and utility costs remain high from consistent artificial light consumption, the economic viability of indoor growing is decreasing. Another main reason for growing marijuana indoors is privacy. The legalization trend continues to increase, and there are few practical reasons to grow in an indoor environment.

See the data below for additional information:



- The electric bill for a 120,000 square-foot warehouse using 22,320 kilowatt hours is about \$38,100 per month compared to \$9,525 for the same size greenhouse using 5,580 kilowatt hours. (www.mainstreet.com)
- Prices in Colorado fell from \$4,000 per pound in February of 2014 to \$1,200 per pound a year later. Wholesale prices may reach \$500 per pound in late 2015. <http://mjbizdaily.com/fears-of-rec-price-crash-bloodbath-in-colorado-as-regulatory-changes-take-hold/>
- When compared to converted warehouses, greenhouse cultivators have the ability to grow up to 200% more product per square foot at half the cost. <http://www.trgrowco.com/news/2015/5/6/growco-cannabis-greenhouse-nears-completion-and-signs-first-tenant>

The Solution

As an industry leading greenhouse manufacturer since 1967, Nexus Corporation has built thousands of greenhouses across the U.S. In recent years, the company has used its extensive experience to serve the emerging marijuana industry with its line of [System 420™](#) hybrid greenhouses. 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 increasing 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 Nexus 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.

Pre-Fabrication

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 cost 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 pre-fabrication 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 pre-fabrication is the trusses. The [System 420](#) greenhouses use pre-manufactured trusses to support the roof. Pre-fabricated 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 pre-fabricated 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 grow facilities and their use of high intensity grow 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 timeframes. 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 airflow 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. A combination of 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 different crops for greater efficiency.

Environmental Control

Effective climate control is a crucial step towards producing any greenhouse crops 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 set point. 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 grows is the 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 grow lights required for indoor grows.

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 grow lights used in the 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 photoperiod 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 airflow 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 grow facility.

With the overall indoor marijuana industry consuming 1-2% 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 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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