1-Acre 3-Level Vertical Farm
22k ft² Net Canopy Area - Type (3B) Mixed Light Indoor Farm
Corporate Overview

Greengro Technologies is in the business of constructing sustainable low carbon footprint growing systems for superior quality plants and vegetables through a system of fully-automated propriety hydroponic techniques 365 days a year. The products capture a niche consumer market interested in a distinctive, exclusive product produced without using synthetic fertilizers and pesticides in a facility with a low carbon imprint. Greengro has in-depth knowledge of fully automated organic hydroponic greenhouses and grow systems with beneficial attributes in tropical climates.

System
Optimized for multi-crop cycles
Combining vertical hydroponics with multiple spacing venues optimizes production per square foot of grow space. From seedling to juvenile plants, to harvest, vertical hydroponics systems can be utilized.

120 days to reach full production capacity
Crops mature after 90 days and are harvested on a daily basis five days a week on a continuing cycle through the year.

Fully Automated Computer Control System
The control system will monitor the root environment as well as the building environment with wireless technology which enables data to be quickly retrieved both onsite- and off-site via internet. This technology requires the project location has access to internet capabilities.
Scope of work
- Providing hydroponic greenhouse, equipment and plans for indoor production facility
- Provide detailed plans of proprietary hydroponic techniques
- Providing coordination and delivery of all necessary components
- Training and education
- Technical and computer support

The Company also provides the following detailed consultation and educational services as part of the franchise package:
- Needs assessment (identification of building specs, existing architecture and optimal layout and production design)
- Design planning and implementation (project management services)
- Continued Support (individualized to address plant, water and computer issues)

Location and Land
- **Location:** San Jose, California

- **Water:** Source can be from a well, standing ponds, or municipal source. Supply reservoirs will need to be maintained to ensure adequate availability. Water analysis must be conducted to determine amount of salts or minerals from prior farming practices or heavy metals found in waterways.

- **Power:** Required 3-phase from grid. May be supplemented with energy from alternate on-site renewable sources.

- **Fertilizer:** The fertigation system will be able to complete the requirements for most all fertilizer regimes. Base ingredients can be purchased locally and our control system mixes a custom recipe for each crop in real time.
Crop Cycle Production Assumptions

The hydroponic Vertical Farm system will accommodate a 12-week grow cycle with options for using vertical racks for increasing plant yields. Each system begins with 1 week of germination, followed by 4 weeks in veg stage and 8-9 weeks in flowering stage. The multi-stage arrangement allows maximum output per square foot by spacing plants as they grow.

Greengro Technologies Inc.
22,000 sq. ft. 12-Bay Full-Auto Turn-Key
Cannabis PV Solar Indoor Vertical Farm

Germination/Clone stage:
Spacing: 3” center
Length: 2 weeks
Total plants in Cloning Area: 4,608

Vegetative stage:
Spacing 12” center
Length: 4 weeks
Total racks per bay: 24
Total levels per rack: 3
Total plants per level: 32
Total plants per rack: 96
Total plants per bay: 2,304
Total plants in veg stage: 9,216
Total bays in veg stage: 4
Total plants produced per week: 2,304

Flowering stage:
Spacing 12” center
Length: 8 weeks
Total racks per bay: 24
Total levels per rack: 3
Total plants per level: 32
Total plants per rack: 96
Total plants per bay: 2,304
Total plants in flower stage: 27,648
Total plants harvested per week: 2,304
Total bays in flower stage: 8
Total bays harvested per week: 1

Estimated Pro-Forma Production Assumption
Average yield per Plant: .25 lbs.
Average yield per Week: 576 lbs.
Average yield per Month: 2,496 lbs.
Average yield per Year: 29,952 lbs.
Average price per Pound: $1,000
Total Estimated Annual Gross Income: $29,952,000
Total Estimated Annual Operating Expense: $4,054,750
Total Estimated Annual EBITDA: $25,897,250

3-Level Vertical Farm Estimated Annual Operating Expense

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<thead>
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<td><strong>Total</strong></td>
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</table>

Estimated Construction Costs

$6,000,000

Work/Materials:
Labor & Material to Erect and PV Glass Gutter Connected Greenhouse

STRUCTURE
• 12 Bay
• Steel Structure, Sidewall and Gable Glazing, Cooling Pad System, & Insect Netting
• Includes (1) 2-Zone Curtain System

STRUCTURE TERMS
• Proposal Covers Specified Materials Only
• Any Federal, State, or Local Taxes That May Be Applicable Now or in the Future are Not Included in This Proposal
• Any Licenses, Permits, Procurement Fees, Certificates and Inspections Required by Any Governmental Authority for Any Part of the Work or Bonds That May Be Required are Not Included in This Proposal
• All Electrical Phases Must Be Confirmed Before Final Design
• Final Design Will Need to be Confirmed by Engineer
• Lead Time Anticipated 8-12 Weeks from Receipt of Down Payment for Material Acquisition

GREENHOUSE LABOR
• Dig and Set Pins, Erect Steel Frame
• Install Glass on Roof and 8mm Polycarbonate on Sides and Gables
• Install Kool Cell Complete (System / Flashing / Insect Screen)
• Install Shade System
• Concrete (Based on Common Footer)
• Material & Labor to Install Boom Rail
• Weld at 24 Splices - Brackets will be Welded on Posts by MNF

Fees and Payments
Terms for purchase the Vertical Farm and head house structure will be 25% down payment to place order, 25% at time of delivery, 25% on construction progress, and 25% balance due upon completion. All other materials will be invoiced with payment due on receipt. Additional shipping charges may apply.

Greengro Technologies provides operating plans, training and food safety plans to meet global GHP/GAP and food safety criteria. Growing in a Greengro Technologies Vertical Farm ensures the highest quality of produce to your customers. Your success is our success and helping to train staff for new markets is just part of what we do!

Facility Design:
Service and Support

Installation of the system hardware and components is a critical step to successful operation. As a value add to our customers, Greengro offer complete turnkey installation of the pond systems and automation. As an alternative, Greengro can provide limited assistance during installation at critical junctures by supply a supervisor to work with local contractors. Business owners will be provided written maintenance and operations manuals.

- User Control and automation
- Pond Installation
Service includes assistance with mechanical and structure components as well as plant, water and computer issues. Also included in the system are personalized quarterly reports that address potential problem areas and provide industry updates.

The Service and Support Package includes:
- Telephone support
- Onsite diagnostic service
- Quarterly progress report
- Industry updates
- Ongoing Employee Training
- Irrigation strategy
- Nutrient strategy
- Interpretation of Water analysis
- Plant growth analysis
- Crop steering
- IT Coordination
- New technology updates
- Yield tracking database

**Packhouse & Installation**

- Fabricate and assemble (15' Ht.) exterior curtain wall panels (10" R-40), reinforced on both sides with appropriately sized and gauge galvanized structural steel tubes 24" on center. The scope and price include the parapet as well as curved wall sections per the aforementioned drawings.
- Fabricate and assemble (10" R-40) roof panels, reinforced on both sides of the panels with appropriately sized and gauge galvanized structural steel tubes 24" on center.
- Factory install engineered headers at door and window openings as per the preliminary plans and specifications, not exceeding 42".
- Include chases on the interior side of the panels at approximately 16" AFF for electrical and utility installation.
- 3. Install lift rings on panels to aid in material movement and erection, if required.
- 4. Supply the following metal accessories as required for installation:
  - Top and Bottom Tracks
  - Outside wall corners
  - Inside wall corners
  - Strapping for connection of intersecting interior partitions
  - Fasteners accessories for assembly
- 5. Provide on-site QA Supervision during assembly. This includes time, travel, lodging, meals and
Side Walls

**Special Notes:**
Fabricated, assemble and install 10" wall panels exterior walls covered with split-side facing, interior walls covered with Walplax 875 highly weather-able and carries UL94 V-0 Rating at .030".

Fabricate, assemble and install 10" cooler wall panels, exterior and interior cooler walls covered by Walpax 875 UL94 V-0 Rating at.030".

Fabricate, assemble and install 10" R-40 roof panel reinforced on with appropriately sized and gauge galvanized structural steel tubes 24" on center. Exterior sheathing of roofing done by others.

Fabricate, assemble and install 12" R-50 perimeter pond walls and waterway wall sections, along with 3" of EPS (96,660) Sq. Ft for pond floor instantiation with 5,000 Sq. Ft of PEX 3/4" tube. Hardware supplied by others. Install Nucor steel truss 8' on center.

Facility Side Walls:
Vertical Farm

Multi-span PV glass Vertical Farm complementary equipment, Passive Solar system, Positive Pressure system, Energy recapture system, Ventilation system, Shading system, Heating system, Cooling system, Humidity system, Irrigation and fertilization system, Light supplementary system, Co2 system, Control system, Air circulation system and Workbench

Overhead View:
The following diagram shows the interior layout

1. Design load
   (1) Snow load: 0.5KN/PMF
   (2) Wind load: 0.50 KM/H
   (3) Rain drainage: 140mm3/h
   (4) Permanent load: 0.4KN/PMF
   (5) Electric: 240V/380V, 50HZ/60HZ

2. Specification
   Size: Length: 170’,
   Column space: 13’,
   Bay: 49’ Width: 36’
   Greenhouse Area: 10,564 sqft
   Height under Gutter: 18’
   Quantity: 1 set
3. Structure and Cover Material
(1) Main Column 120×60×2mm galvanized rectangle, backplane 8mm steel sheet
Side sub column 120×60×2mm galvanized rectangle Cooling system back window column: 70X50X2mm
(2) Grid Architecture: height 2’, Upper and Lower Beam 60×40×3mm galvanized rectangle Webbing rod L40×40×3mm Angle iron shaped
(3) Surrounded Beams: 70×50×2mm
(4) Roof: Roof with aluminum alloy special profiles assembled.
(5) Gutter: 2.75 X 500mm
(6) Greenhouse parts galvanized standard GB/T3091—93.
(7) Greenhouse top and four sides: aluminum alloy special profile, standard GB/T5237—93, Rubber seal.
(8) Connection parts: galvanized
(9) Fitting: Bolts, nuts, washers, self-tapping screws
(10) Cover material: 4mm tempered glass
(11) Drainage Slop: 3%, the rain water through gutter to PVC pipes on ground.

Greenhouse Racking
Rack Framing is Q235B cold rolled steel

Racking System Features
• Loading Capacity: 320 KG/cantilever
• Finished with 60-80 microns epoxy resin static paint. Finish is acid and alkali resistant
• Allowable flexibility length is 1/200 upright max. Allowable flexibility height is 1/1000.
• Upright hole diameter 50mm
• Rhombus hole design plus safety bolt on the beam prevent movement 5-Year Warranty
It’s all about Grams per Cubic Foot
Maximize growing capacity with minimal wattage:
Over the years of designing storage applications for a broad range of markets including agriculture, Greengro Tech has developed a full line of high-density vertical growing systems that will address your grow operation priorities: save energy, optimize space, maximize vertical growing, maximize profits, and improve security. Our vertical growing solutions will provide for a more organized facility that will increase workflow, production, and profits.

Hydroponic or soil growing solutions custom-built
- For your industry
- Growers (greenhouses)
- Agriculture research institutes and laboratories (agtech)
- Medical cannabis (where legalized)
- Recreational cannabis (where legalized)
- Universities - departments of plants science

Mobilize It! Generate Profits From Your Square Footage
Eliminate the need for multiple space-wasting static aisles and use the total potential of your vertical and horizontal space with our rack high-density growing solutions.
Take Growing to a New Level

Montel Multi-Functional High-Density Cultivation Solutions
Discover new square footage you didn’t know you had and reap the benefits in terms of better service and more sales with Greengro’s configurable, space-saving solutions. We’re the one-stop shop for all your agricultural growing needs.

SHOWN WITH 4 LEVELS HIGH 4D WIDE SPAN RACKING 8 X TIMES GREATER STORAGE CAPACITY COMPARED TO STATIONARY ROWS ON THE FLOOR
HEIGHT: 20' HIGH. LENGTH: 65' LONG

High-Density Shelving & Racking

SMARTSHELF® 4-Post Hybrid Shelving:
Make your shelving a perfect fit for a broad array of items with Greengro One-shelf-fits-all four-post patented hybrid system

Adjust shelves at every one-inch without any tools.

4d Wide Span Racking
Improve heavy-duty storage of irregular agriculture items with Greengro long-span, racking system.

Mobilize Your Grow Operations
Mobilize your grow operations Smartspace 2M, 2MA & 2P manual, mechanical-assist, powered mobile system 2,000 lb per bay
Growing Accessories

**LED Grow Lights**
Greengro provides smarter LED grow lights for indoor grow facilities available with Smart Shelf 4-post hybrid shelving systems and 4D wide span racking.

**Perforated Shelves & Panels**
Perforated shelving and end panels for mobile systems to enhance air flow and maximize ventilation throughout the entire storage unit.

**Grow More in Less Space with SMARTSHELF Boltless Shelving**
Greengro has designed the most versatile vertical growing shelving system. You can reconfigure it any time according to your changing growing needs and available space. This also enables you to anticipate your potential grow needs.

**Flexible shelving system designed to be configured and reconfigured easily**

**Easy shelf removal - closed rectangular post VS L&T shape cumbersome post**
• You only need to remove the shelves horizontally. It is very easy to adjust a shelf with 4 simple hooks.

• The unique closed-post design provides easy access to all stored objects as their accessibility is not impeded behind the industry standard's "L" and "T" uprights.

• Additionally, Greengro smart shelf shelves are not tucked behind the closed-post uprights. They do not require to be tipped for removal or adjustment, nor do adjacent shelves need to be displaced to allow clearance for a tipped shelf's removal.

No Tools Required

Greater Grow Space Per Shelf Horizontally & Per Unit Vertically
Vertical shelf adjustment at every 1" (25.4 mm) increments*

Maximize Your Growing Space**
3/4" (19 MM) More Usable Grow Space Per

SmartShell® = 1" (25.4 mm) vs. L&T = 1 1/2" (38.1 mm)

SmartShell® = 1 1/4" (31.75 mm) vs. L&T = 2" (50.8 mm)

* Adjustments for storing objects of various heights. Offers more adjustability and optimizes the space between each level of shelving.

** The smart shelf 1 1/4" (31.75 mm) wide post provides 3/4" (19 mm) more usable growing space per shelf than the industry standard 2" (50.8 mm) wide post.

Do The Smartshelf® Maths
100 sections of 97" (246.38 cm) high with 8 tier back-to-back shelving units would represent:
8 tier shelves
X 2 back-to-back shelving unit
X 3/4" (19 mm) more space per shelf
The Concept: Optimize Your Growing Space
Greengro’s high-density growing systems maximize the use of available space, whether to increase growing capacity, free up room for grow operations, or get rid of space you do not need to pay for.

Eliminate The Need For Multiple Space-Wasting Static Aisles. Here Is How:
• Static units are mounted on mobile carriages.
• Mobile carriages travel on tracks.
• Use the handle to move the manual systems or turn the 3-spoke SafeCrank handle for mechanical-assist systems or push a button on the powered system control to open the desired aisle.

Modes of Operation
• Manual mobile systems
• 3-spoke ergonomically designed rotating SafeCrank handle with soft-touch knobs for mechanical-assist mobile systems.
• Aisle safety push-button located at the core of the 3-spoke SafeCrank handle.
• Powered mobile systems control.
• Powered mobile systems control with PIN for restricted access.

• LCD touchscreen tablet control with or without PIN. Limitless customized displays
Increase Productivity Wirelessly:

ePulse™ Remote Monitoring Software

This remote monitoring & configuration software has the functionality of providing the capability to manage settings remotely and monitor your high-density powered mobile system’s performance and operations with assurance.

Programmable Aisle Automated Features

Users can increase their efficiency by configuring a specific priority aisle(s). While accessing an infrequently used aisle, SmartSpace 2P, SafeAisle® and Rack&Roll 16P mobile racking automatically repositions the system to your designed predetermined aisle(s).

Remote Control

Operators can operate the mobile system remotely with a commercial or industrial rugged remote control mini tablet.
Best In- Class Safety
Safety features for high-density mobile vertical growing systems

Manual Systems:

Optional Safety Foot-Latch
Greengro’s foot-latch safety for manual SmartSpace mobile growing systems is the ideal option to prevent the mobile system from moving. Engaging the foot-latch safety before entering an aisle prevents other users from operating a system already in use.
SmartSpace 2M
Powered Systems:

**Standard Safeties Infrared Foot-Level Safety Beam**
One side of mobile carriage
Photoelectric beam projecting on one side of each aisle is mounted low on the carriage side member.
SmartSpace 2P | SafeAisle® | Tack&Roll 16P

**Aisle-Entry People Counter**
Carriage movement instantly stop when the system detects any beam disruption in front of the mobile system when a user is entering an aisle.
SmartSpace 2P | SafeAisle® | Rack&Roll 16P

**Optional Safety:**
**Infrared Foot-Level Safety Beams**
Both sides of mobile carriage
Photoelectric beams projecting on both sides of each aisle are mounted low on the carriage side members.
SmartSpace 2P | SafeAisle® | Rack&Roll 16P

**Advanced Optional Safety:**
**LED Guard™ Complete Aisle Detection Passive Safety**
100% safety coverage. Prevents any carriage movement when a forklift operator, a user or supply materials are located anywhere within the aisle.

**Mechanical-Assist Systems**

**Standard Safety:**
**Safecrank Safety Push-Button Handle**
To operate the system, rotate the safe crank handle clockwise or counterclockwise. To lock or unlock the safe crank handle, simply press the aisle safety push-button located at the center of the handle.
SmartSpace 2MA | Mobilex® | Rack&Roll 16MA

**Optional Safety:**
**Gravity-Fed Mechanical Safety Brake**
Greengro’s patented mechanical safety brake ensures complete protection for users and objects. The toe-level bar, when pressed, will automatically stop the carriage.
Mobilex®
Case Studies:
Cannabis Mobile Vertical Growing System by Greengro

Greengro mobile vertical growing solutions met this cannabis dispensary’s high standards.

With powered mobile racking, The Grove effectively doubled its on-site yield. It's all about your grams per watt... and your grams per square foot.

Challenges
The legal cannabis industry has taken root across the U.S. as this once black-market drug has gained national recognition for its medicinal and recreational uses.

Business has been booming for The Grove, a medical marijuana dispensary just outside the Las Vegas strip. While many of its successes can be attributed to its attention to growing plants naturally and sustainably, The Grove sought to enhance its use of space to deliver even greater efficiency.

Solutions
Greengro stepped in to help The Grove managers design the ideal grow operation based on their industry’s unique needs. After everything was said and done, Montel installed 29 42-foot long carriages spread across four rooms, increasing The Grove’s storage capacity to over 6,380 square feet with Montel’s powered mobile racking.
We Build Satisfaction

- Greengro pioneered high-density mobile storage systems providing cost-efficient storage solutions using less space.
- Custom-built for your industry
- We've manufactured and installed thousands of projects around the world
Storage Solutions
Help you grow from the inside, optimize and get results

Cogeneration (CHP System)
Our facilities are powered by Cogeneration (also combined heat and power, CHP) is the use of quiet, continuously running equipment (a natural gas burning engine, a generator, and heat recovery exchangers), packaged into an acoustic chamber, to simultaneously deliver both electricity and useful heat. Capturing the latter is what creates the economic saving

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<th>COOLING CONDITIONS PER BAY</th>
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<tbody>
<tr>
<td>Outside Air Temp (DB/WB)</td>
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<td>74.0</td>
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<tr>
<td>Return Air Temp (DB/WB)</td>
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<tr>
<td>Evap Inlet Air Temp (DB/WB)</td>
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<tr>
<th>Supply Fan</th>
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<tr>
<td>Nominal Airflow</td>
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<td>Ext/Total Static Pressure</td>
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<tr>
<th>FULL LOAD COOLING CAPACITY¹</th>
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<tbody>
<tr>
<td>Refrigerant Type</td>
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<table>
<thead>
<tr>
<th>DX Cooling Capacity Data</th>
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<tr>
<td>Total – Nominal Tons</td>
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<td>Total – Actual (Gross / Net)</td>
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<td>Total – Actual (Gross / Net)</td>
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<tr>
<td>Sensible – Actual (Gross / Net)</td>
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<td>Latent – Actual (Gross)</td>
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<tr>
<td>Base Unit Efficiency²</td>
</tr>
<tr>
<td>Application Efficiency³</td>
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<tr>
<td>Refrigerant Charge</td>
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¹ Full load cooling capacity is based on the rated capacity of the system, which is determined by the manufacturer's specifications. The values provided are typical and may vary depending on the specific application and environmental conditions.² Base unit efficiency (EER) is a measure of the system's cooling output per unit of electrical input.³ Application efficiency (EER) is a measure of the system's cooling output per unit of electrical input in the actual application conditions.
### HEATING CONDITIONS PER BAY

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<tbody>
<tr>
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<tr>
<td>Mixed Air Temperature (DB)</td>
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### HEATING TYPE

- **Hot Water**

### HEAT CONTROL TYPE

- **Modulation Ready**

### HEATING FLUID/COIL CONDITIONS

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<tr>
<th>Fluid Type</th>
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<td>Leaving Fluid Temp</td>
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<tr>
<td>Heating Coil Fluid Pressure Drop</td>
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<tr>
<td>Piping Package Fluid Pressure Drop (if selected)</td>
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### FULL LOAD HEATING CAPACITY

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<tr>
<td>Heating Capacity Output</td>
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<tr>
<td>Temperature Rise</td>
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<tr>
<td>Supply Air Temperature</td>
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</table>

Thermal power plants producing electricity for the grid are only able to deliver, on average, 32% efficiency, ie. 68% of the fuel energy consumed is lost to the atmosphere as waste heat. By contrast, CHP captures almost all of the by-product waste heat for heating purposes (space heating or domestic hot water), obtaining a potential efficiency of 85%.

Economic harvesting and exploitation of the waste heat from power production, requires Distributed Generation because heat is not easily transported. It is important to take the source of the waste heat close to the site of utilization. CHP systems take power production to a building or facility where the heat can be gainfully used.
CHP is a well-established technology. Thomas Edison sold heat to nearby buildings from his very first electrical power plant. In Europe, the higher cost of energy has caused wide CHP deployment, but North America is catching up.

Continuously rising electrical costs and a strained, less reliable grid are accelerating adoption of CHP. CHP currently accounts for more than 9% of the electric power produced in the U.S., saving users over $5 billion in energy costs, and preventing the release of more than 35 million metric tons of GHG annually. The advantages of CHP are well documented.

Though the economic case for CHP is solid today, Greengro installation should reap even greater benefits in the future:

1) There is a prospect of significantly higher electrical rates.
   • The desire of society to increase the use of grid electricity from wind and solar will have great environmental benefit but adding these higher cost base renewables will add even more to future electrical costs.
   • Per capita electrical consumption continues to rise dramatically. Adding more capacity to a strained grid adds more expensive peaker plants which add to the capital based rate structure.

2) More Value Added Use of the Waste Heat
   • CHP systems are able to offer great energy efficiency so long as the waste heat can be gainfully used. The waste heat can be captured with heat exchangers for use in space heating and hot water. This means the CHP needs to be sized to match the thermal needs of the building. However, for commercial buildings, the internal cooling load from the inhabitants can exceed the external seasonal load. Today, the only technology, absorption chillers, that can use waste heat to produce cooling, are not generally cost effective.
   • Greengro will be able to offer a patented, proprietary heat driven cooling component that converts CHP waste heat to space cooling far more efficiently and at lower capital cost than absorption chillers.

Unit Range
Our standard CHP units range from 55 kW – 1300 kW electrical and from 84 kW – 1500 kW thermal. Our standard range of units run on Natural Gas, however we also provide Propane, Diesel and Biogas fuelled engines.

Engines
Being independent from any equipment manufacturer we are able select a reciprocating engine prime mover from many suppliers to match exact needs. We are able to offer a variety of engines including Mercedes, Perkins, Caterpillar, and MAN.

Quality Assured
Greengro’s CHP manufacturer has a 2,000m2 production center which incorporates a state of the art CHP test cell. This enables them to test all CHP units prior to delivery to site, ensuring that clients receive a CHP set that has been pre-commissioned.
**Benefits of Cogeneration**
Cogeneration (CHP) is a well-proven technology, recognized worldwide as a cleaner alternative to traditional centralized generation. Its long-term future in the global energy markets is secured by its ability to provide a multitude of financial, operational and environmental benefits from a single unit of fuel.

**Financial Benefits**
- Reduce your Primary Energy costs by up to 50% with the outright Capital Purchase of a Cogeneration system.
- Reduce your Energy bill by up to 20% without Capital Outlay through a Financial Plan (Discount Energy Purchase (DEP) Contract).
- Stabilize the risks associated with rapidly rising electricity prices in your business over a fixed period.
- Provide a non capital-intensive solution for addressing strategic or maintenance issues which can include energy center plant, infrastructure and building fabric improvements and other energy efficiency technologies.
- Cogeneration is an opportunity to be rewarded with a high level of LEED or BOMA Go Green points.

**Operational Benefits**
- Improve the security of your Electrical supply to the site by utilizing the Cogeneration unit as a standby generator at times when the electricity grid fails.
- Improve the security of your Heat supply to the site by utilizing the Cogeneration unit as a standby boiler at times when your boilers are out of service for any reason.
- Limit the need for investment in replacement or new boiler plant by meeting the base load thermal requirements of your site with Cogeneration.
- Eliminate the need for expensive electrical connection upgrades by displacing electrical demand directly or through an Tri-Generation system where the plant produces Electricity, Heat And Cooling simultaneously.
- Through its state of the art technologies and vast experience, we can operate and maintain the plant over a long term, enabling you to benefit from the rewards of Cogeneration or other Energy plant and focus on your core business.

**Environmental Benefits**
- Contribute to global environmental improvement by reducing fossil fuel usage. Operating Cogeneration plant at point of use to generate primary energy improves energy efficiency and reducing the quantity of greenhouse gas emissions, in particular carbon dioxide CO2.
- Lower SOx emissions with the use of natural gas as a fuel.
HVAC & Installation
The HVAC system is the ideal solution to bring fresh, tempered outside air into your facility, regardless of your geographic location. Whether you are in the humidly soaked air of the Southeastern United States, in the drier milder air of the West, or the four-season-friendly confines of the upper Midwest and Northeast, the system can be customized to meet your outside ventilation air requirements. By including the advanced Energy Recovery Module option, your system becomes highly efficient.

HVAC Construction:
Robust 2” Double-Wall Construction
• 2” double-wall and weather-proof roof, floor and wall construction provides up to R8 insulation for energy efficiency and IAQ
• Standing roof seam for strength and durability
• Aluminized steel cabinet construction

Baked-on, Post-Fabrication, Pre-Assembly, Polyester-Powder Paint
• Provides superior corrosion resistance
• Tested to meet ASTM specs
• Electrostatically applied polyester-powder paint `provides superior corrosion resistance for extended equipment life

Full-Length, Piano-Hinged Access Doors for Easy Access
• Easy to open quarter turn latches
• Double-wall construction protects insulation and ensures durability during maintenance

Stainless Steel, Double-Sloped Drain Pan
• Prevents corrosion
• Avoids standing water for high IAQ

Air Flow Management
Low Leak Air Dampers:
• 4cfm/ft² to meet the latest ASHRAE Standards 189.1 and 90.1
• Airfoil blades
• Blade edge and jamb seals
• Provides up to 100% outside air
• Direct drive damper controls

Energy Efficient Airfoil Plenum Fan:
• Energy efficient, quiet, slide-out and pivoting blower assembly with autobelt tensioner
• Premium efficient motor is standard to meet Energy
• Independence and Security Act requirements
Filtration
Best-in-Class MERV16 Filtration:
• 2” pre-filters up to MERV 15
• 4” final filters up to MERV 16
• Significantly lower air-side pressure drop with proprietary final filters (0.15” at 8,500 CFM) requires less motor energy

Serviceability & Maintenance
Energy Efficient Airfoil Plenum Fan:
• Slide-out and pivoting blower assembly with auto belt tensioner on airfoil plenum fan for easy service

Refrigerating Circuit
PF™ Microchannel Condenser Coils from the Company that invented them:
• Reduced depth for lower air side static pressure and lower refrigerant volumes
• Improved corrosion resistance between fin, tubes and headers
• Ideally suited for the high refrigerant operating pressures found in R410A

Modulating Variable Speed Head Pressure Control:
• Regulates refrigerant pressure for use in low ambient temperatures
• Provides energy savings when the fans are running at reduced speeds
• Available with ECM option on B-cabinet units

Modulating Tandem Digital Scroll Compressors are Standard:
• Fully modulating tandem digital scroll compressor down to 10% capacity for maximum efficiency at turndown conditions and high part load efficiency*

Modulating Hot Gas Reheat:
• Provides enhanced supply air temperature control during dehumidification without using additional energy

Electronic Expansion Valve:
• Provides superior superheat control

Composite Sickle Condenser Fan:
• Optional on B-cabinet for increased efficiency and lower sound levels

Control
Greengro’s Control System:
• Factory designed, programmed, and installed integrated control system provides interoperability with all popular network communication protocols, such as BACnet or LonWorks, for easy integration into building automation systems

Heating
Standard Stainless Steel Heat Exchanger:
• Ensured long life with stainless steel tubular heat exchanger for maximum heat transfer – up to 100°F temperature rise
• Modulating capacity turndown ratio as low as 15% of full capacity
• Gas heat also available with supplemental electric heat for enhanced discharge air temperature control
Optional High Efficient Gas Heating Option:
• Upto 94% efficiency with our proven technology – up to 100°F temperature rise

Optional Electric or Hot Water Heat:
• SCR control (up to 100kw)
  * Standard on 10- to 30-ton units. Modulating single digital scroll on 7-ton unit.

Energy Recovery Module
• Maximum of 8,700 CFM outdoor air
• Optional built-in bypass for efficient economizer operation
• MERV10 fresh air filters
• Low static pressure with higher efficiency
• Optional pre-heat for frost control
• Zeolite Coated Aluminum Wheel
  • Unlike silica based desiccants on polymer substrates, this wheel absorbs no odor while providing outstanding heat transfer
• Serviceability and Maintenance
  • Slide out energy wheel and exhaust blower/ motor access panel
• Cabinet sizes include integrated energy recovery option; ships as one unit

Specifications:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Cabinet Size</th>
<th>Data³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Size (Nominal Tons)</td>
<td>B 7</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>C 15</td>
<td>20</td>
</tr>
<tr>
<td>Airflow Range (CFM)</td>
<td>B</td>
<td>1,100-6,000³</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>3,000-12,000³</td>
</tr>
<tr>
<td>Voltages Available (60Hz)</td>
<td>B &amp; C</td>
<td>208V/3ph, 230V/3ph, 460V/3ph, 575V/3ph</td>
</tr>
<tr>
<td>Controls System</td>
<td>B &amp; C</td>
<td>Controls System featuring Carel</td>
</tr>
<tr>
<td>Control Hardware</td>
<td>B &amp; C</td>
<td>Carel PC03</td>
</tr>
<tr>
<td>Optional Communications</td>
<td>B &amp; C</td>
<td>BACNet® MS/TP or Ethernet, LonWorks® FTT-10</td>
</tr>
<tr>
<td>Compressor</td>
<td>B &amp; C</td>
<td>Modulating Tandem Digital Scroll³</td>
</tr>
<tr>
<td>Modulating Range</td>
<td>B &amp; C</td>
<td>10-100%³</td>
</tr>
<tr>
<td>Evaporator Coil</td>
<td>B &amp; C</td>
<td>High Capacity 4 Row, 14 FPI</td>
</tr>
<tr>
<td>Condenser Coil</td>
<td>B &amp; C</td>
<td>PF™ Aluminum Microchannel</td>
</tr>
<tr>
<td>Condenser Fan Qty</td>
<td>B &amp; C</td>
<td>(2) for 7- to 15-ton units, (3) for 20- to 30-ton units</td>
</tr>
<tr>
<td>Condenser Fan Motors</td>
<td>B</td>
<td>Variable Speed for Head Pressure Control</td>
</tr>
<tr>
<td>EEER Part Load Efficiency</td>
<td>B &amp; C</td>
<td>Meets or Exceeds ASHRAE 189.1</td>
</tr>
<tr>
<td>Hot Gas Reheat Coil</td>
<td>B &amp; C</td>
<td>1 Row, 2-Circuit (patent pending), 14 FPI</td>
</tr>
<tr>
<td>Modulating Range</td>
<td>B &amp; C</td>
<td>0-100%³</td>
</tr>
<tr>
<td>Natural Gas Heat Options</td>
<td>B</td>
<td>150, 200, 250, 300, or 400MBH (80%), 175, 225, or 270MBH (90%)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>300, 400, or 500MBH (80%), 350 or 450MBH (90%)</td>
</tr>
<tr>
<td>Efficiency</td>
<td>B &amp; C</td>
<td>80% or 90%+ (Condensing)</td>
</tr>
<tr>
<td>Heat Exchanger Type</td>
<td>B &amp; C</td>
<td>Tubular 409 Stainless Steel with Inshot Burners</td>
</tr>
<tr>
<td>Staging</td>
<td>B</td>
<td>Modulating, 20 to 100%³</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Modulating, 30 to 100%³</td>
</tr>
<tr>
<td>Auxiliary Electric</td>
<td>B &amp; C</td>
<td>Optional, 20kW SCR Controlled</td>
</tr>
<tr>
<td>Maximum Temp Rise</td>
<td>B &amp; C</td>
<td>100°F</td>
</tr>
</tbody>
</table>

Basic Unit Capabilities

Controls

Cooling System

Hot Gas Reheat (Optional)

Heating Section (Optional)
### Electric Heat Options
- **B**: 10 through 80kW
- **C**: 20 through 100kW

### Staging
- **B & C**: Staged or Full SCR Modulating

### Maximum Temp Rise
- **B & C**: 50°F

### Supply Blower
- **Blower Type**: High Efficiency, Backward Inclined, Airfoil Plenum Fan
- **Blower Qty**: 1
- **Blower Sizes (Diameter)**:
  - **B**: 11”, 16”, or 20”
  - **C**: 20”, 25”, or 28”
- **Drive**: Belt Drive with Auto Tensioner
- **Blower Motor Range**: 1 - 15HP, NEMA Premium Efficiency ODP and TE

### Primary Filtration
- **Filter MERV Ratings**: 10, 13, or 15
- **Filter (Qty) - Size**:
  - **B**: (6) - 16” x 25” x 2”
  - **C**: (9) - 20” x 20” x 2”

### Secondary Filtration (Optional)
- **Filter MERV Ratings**: 13 or 16
- **Filter (Qty) - Size**:
  - **B**: (6) - 16” x 25” x 4”
  - **C**: (9) - 20” x 20” x 4”

### Power Exhaust Blower (Optional)
- **Blower Type**: High Efficiency, Backward Inclined, Airfoil Plenum Fan
- **Blower Qty**: 1
- **Blower Sizes (Diameter)**:
  - **B**: 11”, 16”, 20”
  - **C**: 20” or 28”
- **Drive**: Belt Drive with Auto Tensioner
- **Blower Motor Range (HP)**: 1 - 10HP, NEMA Premium Efficiency ODP and TE

### Energy Recovery
- **Wheel Type**: Total Energy Recovery, 4Å Zeolite over Aluminum
- **Wheel Effectiveness**: Minimum 60% to Meet ASHRAE 189.1

### Solar Technology
The solar technology used is an innovative combination of light optimization and solar electricity generation. The patented light-amplifying spectrum absorbs green light and emits red light, which enhance night quality for plant photosynthesis and increase renewable energy production. The light spectrum has been fully vetted with numerous trials on vegetables, cut flowers and ornamentals. The results have shown positive effects on plant growth, attributed to reduced stress from optimized light quality.
Partial solar cell coverage generates electricity.

Shift green light to red light: Improves plant growth and generates power.
Panel Benefits

**Harvest light for power generation**
Greengro panels combine efficient greenhouse growing with solar power production. The panels offset expensive agricultural energy costs and are customizable to any roof configuration and glass size.

**Enhance the solar spectrum for plants**
Greengro panels use a luminescent dye to convert the green light not efficiently used by plants into beneficial red light. Yields under the panel have been positive in extensive plant trials.

**Let your greenhouse pay for itself**
The Panels use photovoltaic cells in a patented interdigitated array. Dye concentration has been selected so that light removed by the cells is offset by the increase in usable red light from the dye.

**Mechanical Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>78.7 in (2,000 mm)</td>
</tr>
<tr>
<td>Width</td>
<td>36.0 in (914 mm)</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.18 in (4.5 mm)</td>
</tr>
<tr>
<td>Module Area</td>
<td>19.68 ft² (1.83 m²)</td>
</tr>
<tr>
<td>Weight</td>
<td>60 lbs. (27 kg)</td>
</tr>
</tbody>
</table>

**Electrical Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>LUMO-90</td>
</tr>
<tr>
<td>Rated Power (Pmax)</td>
<td>90 W</td>
</tr>
<tr>
<td>Maximum PowerVoltage (Vmp)</td>
<td>10.7 V **</td>
</tr>
<tr>
<td>Maximum Power Current (Imp)</td>
<td>8.4 A</td>
</tr>
<tr>
<td>Open CircuitVoltage (Voc)</td>
<td>13.6 V **</td>
</tr>
<tr>
<td>Short Circuit Current (Isc)</td>
<td>9.2 A</td>
</tr>
<tr>
<td>Connector Type</td>
<td>Amphenol® H4</td>
</tr>
</tbody>
</table>

* Taken at STC: Irradiance 1000W/m², Air Mass 1.5, Temperature 25°C. Specified power rating is +3/-2% of indicated Pmax under STC.

** Modules run at low temperature in the field and donot have a significant loss in voltage due to heating when exposed to high irradiances. **
1. General
This specification is applied to PV solar tempered glass/single-side AR coating tempered glass, including criteria for technical, visual inspection, packaging, storage, handling etc. This specification can be used as the technical agreement contracted with customer.

2. Specification

### 2.1 visualization

<table>
<thead>
<tr>
<th>Defects name</th>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclear pattern</td>
<td>—</td>
<td>not allowed</td>
</tr>
<tr>
<td>cockle, mould</td>
<td>—</td>
<td>not allowed</td>
</tr>
<tr>
<td>rainbow, mildew</td>
<td>—</td>
<td>not allowed</td>
</tr>
<tr>
<td>Streak, Abrasion</td>
<td>—</td>
<td>not allowed</td>
</tr>
<tr>
<td>Unmovable stain</td>
<td>—</td>
<td>not allowed</td>
</tr>
<tr>
<td>broken seed</td>
<td>—</td>
<td>not allowed</td>
</tr>
<tr>
<td>Hidden line</td>
<td>—</td>
<td>Inspected against Sample</td>
</tr>
<tr>
<td>impress</td>
<td>—</td>
<td>≤7mm</td>
</tr>
<tr>
<td>bright spot</td>
<td>—</td>
<td>No pass if seeable from distance of 600mm, pass if no seeable from distance of 600mm</td>
</tr>
</tbody>
</table>

### Coating layer scratch

<table>
<thead>
<tr>
<th>Length, Width(mm)</th>
<th>L≤60 and W≤0.3</th>
<th>L&gt;60mm or W&gt;0.3mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable numbers(pcs)</td>
<td>No limits, distance between scratch≥100</td>
<td>Not allowed</td>
</tr>
</tbody>
</table>

### Glass scratch

<table>
<thead>
<tr>
<th>Length, Width(mm)</th>
<th>L≤5 and W≤0.2</th>
<th>L&gt;5 or W&gt;0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable numbers(pcs)</td>
<td>1.0×S</td>
<td>0</td>
</tr>
</tbody>
</table>

### Round bubble

<table>
<thead>
<tr>
<th>Length(mm)</th>
<th>L&lt;0.5</th>
<th>0.5≤L&lt;1.0</th>
<th>1.0≤L&lt;2.0</th>
<th>L&gt;2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable numbers(pcs)</td>
<td>No concentrated present</td>
<td>5.0×S</td>
<td>3.0×S</td>
<td>0</td>
</tr>
</tbody>
</table>

### Elongated Bubble

<table>
<thead>
<tr>
<th>Length(mm)</th>
<th>0.5≤L≤1.0 And W≤0.5</th>
<th>1.0≤L≤3 And W≤0.5</th>
<th>L&gt;3 or W&gt;0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable numbers(pcs)</td>
<td>No concentrated present</td>
<td>3.0×S</td>
<td>0</td>
</tr>
</tbody>
</table>

### Inclusion

<table>
<thead>
<tr>
<th>Length(mm)</th>
<th>0.3≤L≤1.0</th>
<th>L&gt;1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable numbers(pcs)</td>
<td>2.0×S</td>
<td>0</td>
</tr>
</tbody>
</table>

### Crosssection defects

<table>
<thead>
<tr>
<th>Edge Chip</th>
<th>1 chip allowed when length along glass edge measured no more than 5mm, length measured from edge to center is no more than 1mm, depth measured from surface to glass inside is no more than 1/4 of thickness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distortion</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Edge Straightness</td>
<td>Not allowed</td>
</tr>
</tbody>
</table>
1. In the above chart, Φ means the diameter of the round seed, L means the length of the defect, W means the width, Φ, L, W all mean the optical deformation size of the defect. S means the dimension of glass plate (m²), the upper limit value of the amount of seed; foreign matter and block rake are the value which is received by multiplicative S and the corresponding coefficients. According to GB/T8170, this figure should be rounded off to integer.
2. The distance between the seeds, and the distance between the seeds and the foreign matter should be greater than 300mm if the size of the seed is greater than 0.5mm.
3. The dense existence of the round seed refers to the amount of the round seeds are greater than 20 within a circle area, of 100mm diameter. The dense existence of the long seed refers to the amount of the round ones are greater than 10 within a circle, of 100mm diameter.
4. The scratch or foreign matter within a circle area, of 100mm diameter, is not allowed to be more than 2 stripes (pieces).
5. The black pieces are not allowed.

### 2.2 Dimension

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length/Width</strong></td>
<td></td>
</tr>
<tr>
<td>Length≤500</td>
<td>0 ~ -1.0</td>
</tr>
<tr>
<td>500 &lt; Length ≤ 1000</td>
<td>0 ~ -1.5</td>
</tr>
<tr>
<td>1000 &lt; Length ≤ 2000</td>
<td>0 ~ -2.0</td>
</tr>
<tr>
<td>Length &gt; 2000</td>
<td>0 ~ -2.5</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>± 0.20</td>
</tr>
<tr>
<td><strong>Thicknss tolerance in one piece</strong></td>
<td>≤ 0.30</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Diagonal tolerance</strong></td>
<td>≤ 0.10%</td>
</tr>
<tr>
<td><strong>Safty angle at four corners</strong></td>
<td>Hypotenuse 2.0 ~ 4.0</td>
</tr>
<tr>
<td><strong>Warp</strong></td>
<td></td>
</tr>
<tr>
<td>Global Warp for 2.8mm thickness</td>
<td>≤ 0.40%</td>
</tr>
<tr>
<td>Global Warp</td>
<td>≤ 0.20%</td>
</tr>
<tr>
<td>Local warp</td>
<td>Anywhere within 300mm ≤ 0.5mm</td>
</tr>
<tr>
<td><strong>glass transmission</strong></td>
<td></td>
</tr>
<tr>
<td>Non ARC</td>
<td>T2.8mm/T3.2mm ≥ 91.5%</td>
</tr>
<tr>
<td>T4.0mm ≥ 91.3%</td>
<td></td>
</tr>
<tr>
<td>ARC</td>
<td>T2.8mm/T3.2mm ≥ 93.5%</td>
</tr>
<tr>
<td>T4.0mm ≥ 93.3%</td>
<td></td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>≤ 0.015%</td>
</tr>
</tbody>
</table>

### 2.3 Safety

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fragmentation</strong></td>
<td></td>
</tr>
<tr>
<td>2.8mm</td>
<td>The amount of fragments are not less than 15 pcs within any area of 50mm×50mm, tiny amount of strip fragments are allowed, but the length should not be greater than 75mm.</td>
</tr>
<tr>
<td>3.2mm</td>
<td>The amount of fragments are not less than 40 within the any area of 50mm×50mm, tiny amount of strip fragments are allowed, but the</td>
</tr>
<tr>
<td>Impact</td>
<td>6 pcs samples will be tested. If the number of damaged pieces is within 1, this test is OK. If the number of damaged pieces is 3 or more than 3, this test is failing. If the number of damaged pieces is within 2, take another 6 samples for test, if the damaged piece still happens, this test is failing.</td>
</tr>
</tbody>
</table>

3. Validation Procedure

3.1 Dimension Inspection

The measurement shall be taken by band tape with minimum scale unit of 1 mm.

3.2 Thickness Inspection

The measurement shall be taken by micrometer at the centers of the 4 sides with distance of 15 mm from edge. The thickness shall be verified on average value of four points in mm.

3.3 Visual Inspection

Cosmetic defects shall be viewed from a distance of 0.9 meter over a matte black background using diffused daylight. All visual inspections for cosmetic defects shall be made from a distance of 0.9 meter perpendicular to glass by naked eye.

3.4 Transmission

Transmission shall be measured with an optical spectrometer OPTEK GST. See Figure below for Transmission ratio measurement. Transmission shall be measured to surface points between integral sphere and light source on the air-float station. Measurement will be taken on 15 points of 3 lines from up\middle\down locations. 5 points on each line will be taken. Average value of 15 points will be taken as transmission ratio.
3.5  Fragmentation

3.5.1 Glass from in-line production will be taken as samples. Samples will be placed horizontally on the test table protected by safety surroundings in case of broken glass.

3.5.2 Glass is broken by small hammer with tip size of 0.2mm ± 0.05mm pinching in the middle of glass which is 20mm away from long side edge.

3.5.3 Particle pattern for counting should be kept 10 seconds after pinching action and closed within 3 minutes.

3.5.4 The particle count shall be not made in the region of pinch point radius of 80mm and 25mm away from glass edge. The particle count shall be made in the coarsest fracture. The particle count shall be made by placing a mast of 50 +/- 1 mm square on the test piece. The number of crack-free particles within the mask shall be counted. Particles cross frame should be counted as 1/2 piece. (see figure below)

![Diagram](image)

3.6  Impact test

3.6.1 Glass from in-line production will be taken as samples with size of 610mm × 610mm.
3.6.2 The sun-towards surface will be taken as impacting face. If impacting face can’t be decided, then two sets of samples will be tested. The surface with lower test results will be taken. Drop a 38 mm diameter 227 +/- 2 gram steel ball from a height of 1 meter at 90 degree at the center of the glass within the region of diameter 25mm from impacting point. One piece glass can only be tested for one time. Glass will be observed for broken or not. Test will be done at normal room temperature.

3.7 Warp

3.7.1 Global Warp (Bow): The bow shall be measured when placed in a vertical position and supported on its longer side by two load bearing blocks at the quarter points. The deformation shall be measured along the edges of the glass and along the diagonals by straight rule or tape. The percentage ratio between height of arc and the length of spring will presents Global Warp (Bow).

3.7.2 Local Warp (Kink): Samples will be vertically placed. Kink shall be measured over a limited length of 300 mm by using a straight edge, parallel to the edge at a distance of 25 mm from the edge of the glass. Kink shall be measured the maximum gap between feeler gauge and glass. The percentage ratio between gap value and 300mm will presents Local Warp (Kink).

3.7.3 Calculation of Warp \( c = \frac{h}{l} \times 100\% \) in the formulation:

\[ C = \text{Warp, unit } \% \; ; \]
\[ h = \text{height of arc or the depth of valley, unit } \text{mm} \; ; \]
\[ l = \text{distance from height of arc or the peak to peak. Unit } \text{mm} \; . \]
The Value of Incentives

The renewable energy incentives listed below can reduce the upfront cost of a new greenhouse by up to 30%, and pay for the solar energy system. Greengro is uniquely positioned to offer these savings because the solar energy system combines a crop protection environment with renewable energy generation.

**Investment Tax Credit (ITC)**
- ITC is a dollar-for-dollar tax reduction in your federal tax liability
- ITC is a 30% tax credit based on the amount of investment in solar energy projects.
- With this greenhouse-integrated solar, eligible costs includes the solar energy system, the greenhouse support structure, and all related installation costs.

**Modified Accelerated Cost Recovery System (MACRS)**
- MACRS is a method of depreciation in which you investments in solar energy equipment are recovered in annual tax deductions.
- With this greenhouse-integrated solar, eligible equipment includes the solar energy system and the greenhouse structure.
- For projects on which ITC is claimed, only 85% of the eligible equipment can be depreciated with MACRS.
- For the first year of depreciation, owners are able to deduct 50% of the eligible system cost.

**Rural Energy for America Program (REAP)**
- REAP is a federal grant from the USDA that pays for 25% of renewable energy projects, up to $500,000.
- REAP is available to agricultural producers and rural small businesses, with bi-annual application periods.
- With this greenhouse-integrated solar, eligible project expenses include the solar energy system.
- REAP proposals are evaluated based on point scoring rules.
- Greengro has a high success rate in obtaining grants for our customers, and we will do all the grant paperwork.
Irrigation & Installation

Treatment System #1 is designed to adequately aerate the rainwater storage basin to maintain good dissolved oxygen levels to reduce algal and other growth.

Treatment System #2 will then purify 25,000 gallons per day of that rainwater for use as the primary source water for the facilities irrigation and maintain the 15,000-gallon storage tank free of algae and biofilm accumulation. Additionally, with the addition of some simple plumbing, there is capacity to alternately batch-treat several thousand gallons per day of irrigation runoff water stored in runoff capture pond, potentially allowing this to be a zero runoff facility.

Treatment System #3 is designed to continuously recirculate, filter and treat the approximately 1,270,000 gallons of nutrient rich water in main growing pond. This system will reduce water borne pathogen to levels that present no threat of disease to the crops. ORP levels will be elevated to provide residual oxidation capacity for biofilm reduction the pond and piping systems. A substantial residual benefit of the oxidation process with ozone is the elevation of Dissolved Oxygen levels in irrigation water to improve oxygen delivered to plants, which has been demonstrated to improve plant health and production yields.

This dosing levels in this system assume that the rainwater basin is aerated with a micro-diffusion aeration system that will actively “turn-over” the source pond a minimum of 20 full turns per day to prevent establishment of a thermocline and a sludge accumulation in the basin bottom, and to maintain uniform temperature and dissolved oxygen levels in the basin.

Treatment System #4 is designed to inject automatically a single stock solution fertilizer and sulfur dilution stock solution, based on flow rate, E.C. set point and pH set point, and to maintain stable E.C. and pH levels in the Cultivation Pond

Seedling Rack Irrigation System is designed to deliver irrigation water to 15 seedling racks with each seedling rack containing twelve shelves of eight 4’x4’ “flood” type trays with overflow drains. Each tray will have a capacity of 16 liters per hour of maximum irrigation. Each of the 15 racks will be controlled as a separate irrigation zone.

Design Assumptions:
This system is designed based on the assumptions outlined below. Your review of these is important. If any item is incorrect it may affect the entire design and cost.

Primary water source: Primary: Rainwater stored in outdoor basin
Secondary: Well water stored in outdoor basin

Tertiary: Incidental runoff from irrigation and waste water Maximum source flow:
Up to 20,000 gallons per day @ 40gpm from rainwater basin

Water Storage:
• Rainwater storage basin: 480,000 gallons
• Treated Rainwater Day Tank: 15,000 gallons
• Growing Pond: 1,270,000 gallons

Water to be treated: 100% basin and growing pond water
Treated water volume:
• Up to 57,600 gallons per day of rainwater basin water, or lesser amount of rainwater plus unspecified volume of dirty drain water.
- 720,000 gallons per day of Cultivation Pond water.

Treatment Flow Rates: Rainwater Basin: 40gpm continuous recirculation rate
Cultivation Pond 500 gpm continuous recirculation rate

Irrigation period: 24 hours per day Type of fertilizers used:
Non-organic Type of growing media: No media
Available Electrical: 120/220/277/480V 3-phase. Selected voltages to be confirmed.
Expansion requirements: None

Treatment Process Flow Summary:
Following is a step-by-step description of how your system will function. This “flow configuration” may be changed once we have confirmed final details.

Step 1: Hydroponic Aeration
A single aeration disk and set of small compressors (both included) will pump up to 20 million gallons per day of the rainwater basin, turning over your pond far more than 20 times per day. This keeps the basin clean and reduces demand for treatment.

Step 2: Hydroponic water pressurization and transfer
One constant speed pump (included) will pump water at 40 gpm continuously at 50psi from the basin to its dedicated treatment system for makeup water to the 15,000-gallon day tank. A 2 HP pump is supplied with a foot valve and required check valves.

Step 3: Pre-Treatment Filtration:
Basin water will first be directed through two 21” depth media filters filled with AgPlus media (included). These filters will remove particulates down to approximately 5 microns before in size before discharging into the tanks. This will remove the majority of particulate as well as some of potentially pathogenic microbes, keeping the tanks clean and reducing demand for the ozone system.

Step 4: Ozone Reaction and Treatment
Pre-Filtered water then flows through an 80-gallon pressurized Ozone Reaction Vessel (ORV) (included) where it is introduced to highly ozonated water from the Ozone Generation System. In the ORV organic contaminants are oxidized and residual ozone remains in the water to be carried to the storage tanks thus elevating the ORP and Dissolved Oxygen of the water in the storage tanks.

Step 5: Ozone Generation & Control
A side-stream of water is drawn from the incoming untreated water and circulated through the Ozone Generation System (included) where it is injected with a high concentration of ozone and then introduced back into the main stream of water flowing into the ORV (step 4). The Oxidation Reduction Potential (ORP) (treatment level) is continuously monitored and controlled by an onboard touch-screen controller that modulates the ozone output to maintain the desired ORP level in the water returning to the storage tank.

Step 6: Storage Tank Fill and Mixing
The high ORP/DO ozonated basin water is delivered to the 15,000-gallon main storage tank (not included) through a 2” manifold pipe inside on the bottom of the tank with four Mass Transfer Nozzles (included) to distribute the high ORP, high DO water from the treatment process uniformly through the tank volume. This assures that the water is efficiently mixed into the existing water and is done so under pressure to maintain the dissolved ozone and dissolved oxygen as the water is introduced to the tanks. This is an important step in maintaining the ozone and dissolved oxygen in solution as both degrade, the ozone very quickly and the dissolved oxygen over a longer period.

Step 7: Storage Tank Recirculation and Re-Treatment
Once the storage tank is full, it will be allowed a controlled overflow. The overflow will return to the rainwater basin to pre-treat that water. A set of automated electric ball valves (included) will also allow the overflow to be directed back to the inlet of the 40-gpm pump to be reprocessed continuously. This step may be employed during drought conditions or heavy rainfall that has allowed polluted water to enter the basin and increased the disinfection demand. These valves are controlled by controller onboard the Ozone Generation System skid. The recirculation treatment process allows establishment of the highest quality, safest water with high dissolved oxygen levels.

Step 8: Cultivation Hydroponic Refill
A 2” solenoid valve (included) will open and allow gravity refill of the Cultivation Pond from the 15,000-gallon fresh water storage tank. This water can be introduced anywhere in the pond that the plumbing is convenient.

Step 9: Cultivation Hydroponic Water Repressurization and Recirculation
A single 30HP pump (included) (or alternatively a pair of 15HP pumps) will draw 500 gpm from a suction manifold extending the entire 460’ length of the pond. This water will be pressurized to 58 lbs. This pump will recirculate water 24 hr./day.

Step 10: Pre-Treatment Cultivation Hydroponic Water Filtration
The flow from the pump(s) will then flow through an array of four 48” depth media filters. These filters will remove particulates down to approximately 5 microns before ozonation.

Step 11: Ozone Reaction and Treatment
Pre-Filtered water then flows through a 460-gallon pressurized Ozone Reaction Vessel (ORV) (included) where it is introduced to highly ozonated water from the Ozone Generation System. In the ORV organic contaminants are oxidized and residual ozone remains in the water to be carried to the storage tanks thus elevating the ORP and Dissolved Oxygen of the water in the storage tanks.

Step 12: Ozone Generation & Control
A side-stream of water is drawn from the incoming untreated water and circulated through the Ozone Generation System (included) where it is injected with a high concentration of ozone and then introduced back into the main stream of water flowing into the ORV (step 4). The Oxidation Reduction Potential (ORP) (treatment level) is continuously monitored and controlled by an onboard touch-screen controller that modulates the ozone output to maintain the desired ORP level in the water returning to the storage tank. Dissolved Oxygen is also continuously monitored on this skid.

Step 13: Nutrient Injection
A side stream of treated water will now flow through an injection loop where the E.C. and pH sensors (included) will continuously monitor, and an electronic controller (included) will control the pulsing rate of the fertilizer and acid injection heads (included) to maintain the desired E.C. and pH setpoints.

Step 14: Cultivation Hydroponic Pressurized Distribution
Treated and fertilized water will not be reintroduced into the pond at a pressure of approximately 30 psi evenly distributed through 72 individual Mazzei Mass Transfer Nozzles (MTNs) (included). A manifold will run down the 460’ length of the pond (PVC not included). At each of the 12 “bays”, a branch will tee off of the main manifold and feed 41.7 gpm of flow through 3 paired sets of MTNs spaced evenly down the length of the bay. This will assure that the fresh oxygenated water will be uniformly distributed and pushed down to the opposite end of the bay, in the same direction as the crop flow, to where it will be drawn out again and retreated.

Components and Services:

Rainwater Basin
1/3 HP each Dry-Oilless Manual Starter
Pressure Relief Valve

[1] LTC Aeration Disks (for new “main” pond) 48”
Triple Surgical Laser Cut 12” legs
Feeder Tube Connector fittings

[1] LTC Aeration Disks (for upper settling pond) 48”
Triple Surgical Laser cut 4 12” SS Legs
Feeder Tube Connector Fittings

[75’] Self-Sinking Feeder Tubing
¾” Weighted Tubing

[1] Pond Repressurization Pump and VFD
Goulds 2 HP
40 gpm
115’ TDH
Outlet check valve Screened Foot Valve

[2] Rainwater Basin 21” Depth Media Filters
[2] 21” Depth Media Filters and automated backwash valves NXT electronic backwash controls
No-Raw-Water-Bypass Backwash Pistons
Separate Source Backwash water valves

[1] Rainwater Basin 1.5 lb./day Ozone Generation Skid and ORV
Integrated air compressor and oxygen concentrator Ozone Generator
Back Flow Preventer
Touch Screen ORP controller ORP Sensor and Analyzer Ambient Ozone Alarm
80 Gallon ORV
Ozone Injection pump and Injector Assembly

[2] Actuated Ball Valves
3” Ball Valves
12-24VAC Actuator Motor End Switches

[1] Solenoid Valve
2.5” Fast Acting

[76] Mass Transfer Nozzles
7.5 -10 gpm per nozzle

[1] Cultivation Pond Pressurization Pump
30 HP @ 135’ TDH
Motor Starter Panel Operation Lights Outlet Check Valve Inlet Check Valve Isolation Butterfly Valves

[1] Cultivation Pond Air Preparation Skid:
[1] Rotary Scroll Air Compressor Skid
- 7.5 HP
  - 480 Volt, 3 phase, 60 Hz
  - All associated controls, gauges, and filters

[1] Oxygen Concentrator AS-E Skid
- Oxygen Output: 250 SCFH @ 0-45 psig
- Dew Point -100°C
- Oxygen Purity: 90% +/- 5%

- Feed Air: 47 SCFM @ 90-150 psig
- Skid Mounted with Oxygen Receiver Tank and Regulator
- Dew Point Monitor

[1] Cultivation Pond Ozone Generation Skid:
[1] 15 lb./day Ozone Generator OWS-0300

[1] Interface Panel
- Touchscreen Interface
- ORP PID Controller for 4 – 20 mA
- Emergency Stop Button
- Motor Starter (Pump Status)
- ORP Analyzer (4-20) + Two (2) Relay Outputs
- Alarm Annunciator:
  - Ambient Ozone Alarm (Soft)
  - Dew Point Monitor (Soft)
  - Gas Flow Switch (Soft)
  - Water Flow Switch (Soft)
  - Back Flow Prevention (Hard)
  - Treated Water Flow Input

[1] Backflow Prevention Devices
- Wetted Materials: Stainless Steel (300 Series, Glass, Viton
- Positive shutdown solenoid valve
- Fault warning and Normal Operation lights
- Compound Gauge: -30 – 30 psig for Pressure Indication
- Dry Contacts for Remote Shutdown of Ozone Generator and External Notification.
[1] Ozone Injection Loop
- Ozone Injection Pump
- Water Flow: 119 GPM
- Motor: 7.5 HP
- Power: 460/3/60
- Material: 316L Stainless Steel
- Seal: Viton
- Magnetic Motor Start (Interface Panel)
- Stainless Steel Inlet/Outlet, 3” Flange
- Three (3) SS Pressure Gauges
- Two (Isolation Valves for Pump)
- One Pump Check Valve (Water Flow)

[1] Injection System:
- High efficiency Kynar injector

[1] ORP Analyzer Controller
- Signet 9900,
- Dual Relay Outputs and One (1) Analog Sensor


[1] Cultivation Pond Ozone Reaction Vessel
- 463 Gallons
- FRP- pressure vessel
- 48” D x 72” H
- Inlet Distribution Grid and Flange Connection
- Degas valve assembly

[8] Cultivation Pond Pre-Treatment 5-Micron Filters
36” Depth Media Filters and automated backwash valves NXT electronic backwash controls
No-Raw-Water-Bypass Backwash Pistons
Separate Source Backwash water valves

[1] Filter Manifold Fittings and Isolation Valve Materials
Schedule 80 PVC
2” Tees, elbows, unions
2” Isolation Union Ball Valves Filter bypass fittings
Pressure Gauge tees
Pressure Gauges

[6] Pressure Gauges
Stainless Steel, glycerin filled.

[4] Irrigation Water Storage Day Tanks
[4] 3,500 gallon Roto Plast tanks 96” X 125”
[8] 3” Bulkhead fittings
[1] Tanks Tank level Float Assembly

[1] Injection Components
[1] pH Sensor
[1] 24V sample pump

Seedling Rack Irrigation System
[2,900] Pressure Compensated 8lph drippers w/18” leads [2] 1000’ rolls of 16mm tubing and related fittings
[180] 16mm ball valves
[23] sections of Poly Rail support extrusions and related fittings [1] 15 Station irrigation Controller
[1] Nursery Rack System
[1] Pond Rafts

[1] Hand Held ORP meter for calibration and performance monitoring
[1] Hand Held Oxygen Analysis meter for system performance monitoring
[1] Hand Held Dissolved Oxygen Meter and calibration solutions for monitoring DO

[1] Project Services
[9] Site days over a total of 5 site visits for final planning, installation guidance, completed installation inspections and system certification


[1] System documentation and drawings package, including two owners binders with all O&M manuals and drawings, 3-D CAD installation drawings of water treatment system and detailed P&ID drawings

[1] Unlimited remote design and installation support

To be supplied by customer
- All electrical service and final connections to each treatment system component
- Contracting of labor services estimated below
- Receiving of all shipments

Delivery Schedule: Allow approximately 12 weeks from date of order for delivery of all components.
Additional Water Treatment System Information

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Lucas Greenhouses

System Description
This is the original system installed at Lucas Greenhouses and was placed in service in 2009. It serves 3 flood floor storage tanks of 17,500 gallons each, although presently 2 of these are interconnected and act as a single tank that receives all return water from the flood floors. The third tank is the flood floor source tank and a treatment circulation pump runs continuously to treat the water in this tank. The original design was to treat each of the 3 flood tanks individually, however the customer no longer requires multiple feed tanks for this flood floor system.
Step 1. Course return water Filtration: All water returning from the flood floors is pre filtered through a Kason vibrating screen filter to approx. 50 microns before re-entering the tank. This reduces the demand in the tank and also in the fine filtration that follows.

Step 2. Tank Selection: The tank to be treated is selected by the Argus computer for treatment and the water is pumped at the rate of 125gpm from that tank through the treatment process. The recirculating pump is equipped with a VFD so constant pressure can be maintained downstream from the filters as they become loaded.

Step 3. Pre Treatment Fine Filtration: The first step of treatment is an array of 4 pre treatment deep media filters that filter out particulate down to 54 microns at about 95% efficiency. These filters are auto backwashing and backwash based on a specified time or hours of operation. The filters are backwashed with fresh unfertilized water. Each filter can be backwashed independent of the other so there is never an interruption of flow. The media in these filters is a crushed glass media made from recycled glass products. This crushed glass media allows much finer filtration levels than other media such as silica, sand, Zeolite or mixed medias and it is non-depleting and requires approx. 256% less back wash water.

Step 4. Ozone Contacting/Disinfection: This is a custom-built pressure vessel with a baked on oxidation proof lining inside and out and it is where the primary disinfection takes place. From the 54 Micron filtration, water flows into the top of the Ozone Contact Vessel while a stream of super ozonated water. From the Ozone Generation skid is simultaneously circulated into the bottom of the Contact Special patented plumbing in this vessel assures that the untreated water is contacted by and thoroughly mixed with the highly ozonated water under pressure to assure maximum disinfection. Ozone is the most powerful oxidizer available working 3,100 times faster than chlorine and with 40,450 times more killing power, meaning that a very short contact time of only a moment is required to be effective. The water is ozonated in the contact tank to a level sufficient to carry a high residual ORP, in the 500 to 600 mV range, back to the flood storage tank being treated.

Step 5. Flood Tank Mixing: When the Ozonated high ORP water returns to the in ground storage tank it is introduced into the tank through a group of eductors (special jet nozzles that remix and direct the water) in the tank that assure that the water is thoroughly and continuously mixed in the flood tank. This high ORP water is then able to further disinfect the water already in the tank and keep the tank walls and the irrigation piping system free of biofilm buildup. A very beneficial result of this design is that the water in the storage tanks is able to maintain an elevated level of dissolved oxygen that is beneficial to the plant root system and plant health.

SYSTEM #2 DESCRIPTION
This system was installed in 2011 and 2012. It serves a total of five tanks plus the large runoff pond between the greenhouses. This system, like the original system, is designed to treat the flood floor tanks for this section of the greenhouse; and it is designed to reuse the runoff water from the pond and to remove the chemical residues from the pond water before it can runoff. This system closes the water loop at Lucas Greenhouses and is designed to assure that any water that does leave the pond as the result of a rain event is clean and safe before it goes downstream. The system serves a total of 5 in ground tanks (3 @ 26,000 gallons, 1 @ 45,000 gallons, and 1 @ 99,000 gallon) plus the pond.

Step 1. Pond Aeration: Aerating the pond is a critical first step in the water treatment process because it assures that all of the water in the pond is of the same quality (clarity, demand, DO), and that the bio loading and turbidity of the pond and therefore the oxidation demand and pathogen load are reduced before filtration and treatment. Special aeration disks and a compressor facilitate as
many as 20 turnovers per day of the total water volume in this pond.

Step 2. Tank Selection: One of the 5 in ground concrete tanks, or the pond, is selected by the Computer to be treated. The water is pumped at the rate of 200gpm from that tank or pond through the treatment process. Each tank is treated until the ORP level of the water in that tank meets or exceeds set point target, at which time the computer switches to either the next tank in the line, or to the tank currently being used for irrigation.

Step 3. Make Up Water Treatment: The make up water for the flood floors and overhead irrigation Systems is designed to come from a treated water storage tank. This water is to come from either the well or from the pond and is filtered and disinfected in the process described below before being stored in this tank for use in the system. This allows Lucas to control the quality and safety of all water introduced into their systems on a batch basis, providing time to deal with problems without damaging crops.

Step 4. Course Return Water Filtration: All water returning from the flood floors is pre filtered through a Clear Stream cloth media filter to approximately 30 microns before re-entering the tank. This reduces the demand in the tank and also in the fine filtration that follows.

Step 5. Pre Treatment Fine Filtration: The first step of treatment is an array of six pretreatment deep Media filters that filter out particulate down to 54 microns at about 95% efficiency. These filters are auto backwashing based on a specified time or hours of operation. The filters are backwashed with fresh unfertilized water. The media in these filters is Vitro Clean crushed glass media. This media allows much finer filtration levels than medias such as silica, sand, Zeolite or mixed medias; and it is non-depleting and requires approximately 25% less back wash water.

Step 6. Ozone Contacting: This is a custom build pressure vessel with a baked on oxidation proof lining Inside and out. This is where the primary disinfection takes place. From the 54 micron filtration, water flows into the top of the Ozone Contact Vessel while simultaneously a stream of super ozonated water, from the Ozone Generation skid, is circulated into the bottom of the Contact. Special patented plumbing in this vessel assures that the untreated water is contacted by and thoroughly mixed with the highly ozonated water, under pressure, to assure maximum disinfection. Ozone is the most powerful oxidizer available, working about 3100 times faster than chlorine and 40450 times more killing power, meaning that a very short contact time of only a moment is required to be effective. The water is ozonated in the contact tank to a level sufficient to carry a high residual ORP in the 500 to 600 mV range back to the flood storage tank being treated.

Step 7. Post Treatment Fine Filtration: After leaving the contact tank the water flows through an array Of four post treatment deep media filters that filter out particulate down to 54 microns at about 95% efficiency. These filters are identical to the pre treatment filters. The purpose is to remove the particulate that has precipitated out during the heavy oxidation process in the contact tank to prevent fouling of valves, floors and emitters downstream. In addition to being a very powerful oxidizer, ozone also functions as a good broad-spectrum micro flocculent pulling together particles for easier filtration.

Step 8. Flood Tank Mixing: When the ozonated high ORP water returns to the tank it is introduced into the tank through a group of educators (special jet nozzles that remix and direct the water) in the tank that assure that the water is thoroughly and continuously mixed in the flood tank. This high ORP water is then able to further disinfect the water that is inside the tank and keep the tank walls and the irrigation system free of biofilm buildup.
Step 9. Advanced Oxidation Process: Before returning to a tank, a set of diverter valves can redirect the water to a Ultra Violet (UV) light unit to trigger an Advanced Oxidation Process, which is a third level of treatment. Advanced Oxidation instantly breaks the bonds of the O₃ molecule (ozone) creating a hydroxyl radical (OH). This reaction lasts only a moment but is the strongest oxidant that can be applied in water is able to oxidize any compound present in the water. OH reacts unselectively so any contaminant will be quickly fragmented and converted into small inorganic molecules. It will break down aromatics, pesticides, PGRs, petroleum constituents and volatile organic compounds. The Lucas system is designed to allow this process to be applied to the treatment process of any tank, but is particularly aimed at treating the water being returned to the pond.

Step 10. Bio Filtration: From the UV unit, the water flows through a set of Bio filters before returning to the tank or pond. The water in the largest 99,000 gallon treated water tank is continuously circulated through the Bio Filters unless water from other tanks is currently flowing through them. The purpose of the Bio Filters is to break down nitrates and any remaining unknown chemical compounds resulting from the Advanced Oxidation process before returning this water to the pond. There are two Bio Filter tanks. Both tanks are filled with a special media that is conducive to attracting and retaining a microbial biofilm buildup of selective bacteria. Both tanks are served by a single Bio-Activator (Bactivator) that delivers the live bacteria to each tank. These tanks operate in two stages: the first Stage tank has a lower oxygen anaerobic environment to start the process of anaerobic digestion to break down the chemical bonds and nitrates. The second tank a slightly more aerobic environment to complete the process. From here the water returns to the tank or pond.
Countryside Garden Center

1. Up to 100gpm is pumped from "sock well" or, if selected, from deep well, or, in the future, from the pond

2. Well or pond water flows through a series of 3 custom sized deep crushed glass media filters where it is filtered down to 5 microns @ 95% efficiency (that's would be the equivalent of about 2,500 mesh)

3. A dedicated, skid mounted Ozone Generation System pulls ambient air into compressor and oxygen concentrator, and then pumps 99% pure oxygen into a Corona Discharge Ozone Generator, which in turn produces pure ozone in quantities sufficient to completely disinfect the water being treated.

4. Super concentrated ozonated water from the Ozone Generation System is circulated through the Ozone Reaction Vessel to introduce the ozone necessary to disinfect the water.
5. Filtered water is introduced under pressure into the Ozone Reaction Vessel where it collides in a patented counter flow process with the concentrated ozone water from the ozone generator. This process assures that 98% of the water molecules are contacted by ozone and are pathogenic microbes are immediately destroyed. All forms of bacteria, protozoa, fungi, algae, etc. are destroyed in a process called lysing that does not allow them to survive or reproduce and does not clog drip emitters.

6. After reaching a level sufficient for complete disinfection and destruction of pathogens, the ORP (Oxidation Reduction Potential) of the water is raised still higher to a level that provides sufficient residual ozone to carry out through the downstream filters, tanks and irrigation lines and keep them free of biofilm.

7. In the Reaction Vessel, and in the lines downstream of that vessel, the ozone begins to revert back to its original state of oxygen. Since ozone is 12 1/2 times more soluble in water than pure oxygen, this results in a higher level of dissolved oxygen being imparted to the water than is possible under normal circumstances. The elevated dissolved oxygen level is ideal for maximizing the root system of the plants to develop healthier plants.

8. Completely disinfected water then flows through a set of 2 deep crushed glass media filters where residue from the strong oxidation process in the reaction vessel is removed to assure that there will be no clogged valves or drip emitters.

9. Highly polished, pathogen free clean water with high levels of dissolved oxygen is deposited into the storage tank where it awaits use for irrigation.

10. Water from the storage tank is re-circulated 24 hours a day from the tank and back to the Reaction Vessel where it is re injected with ozone to maintain pre set ORP levels in the water in the tank. This process assures that the water in the tank remains as clean as when it was put into the tank; that the tank walls and all downstream irrigation systems remain completely free of biofilm; and that the water going out to the plants maintains a high level of dissolved oxygen.

11. A variable frequency drive pump sends the water out to the irrigation systems as needed.
Metrolina Greenhouses

This integrated water treatment system is being installed now at Metrolina and is expected to be operational before the end of February. It will serve the downstairs young plant production area, and alternatively, the water can also be diverted to the MX2 range.

The pond aeration and treatment system is designed to completely disinfect and filter up to 1,000 GPM of water from the upper east pond and use that for boom irrigation of plugs and liners.

The initial phase of this installation was implemented last winter with the installation of pretreatment 54micron filtration for 1,000 GPM. That filtration system was originally designed to be expandable to 1,500 GPM by the addition of a third filter vessel. Now, instead of adding the third filter vessel, an ozone system and post filtration has been added, along with pond aeration.

Step 1. Pond Aeration: 12 ADS microdiffusion aeration disks are strategically placed in the bottom of the large pond. These disks are supplied with the correctly engineered air supply from a high end Kaeser ComPak 15 HP Rotary Lobe Blower. The micro diffusion disks are 4’ in diameter and each disk holds 100’ of tubing with 2,400 surgical microcuts per disk. Each of these cuts emit approximately 5 micro bubbles per second, so one disk operating 24 hours per day will emit over 1 billion bubbles per day. At the depth of these ponds that enables each disk to effectively pump 22 million gallons per day from the bottom of the pond to the top. With 12 disks at varying depths in this pond, that equates to aeration pumping capacity of about 400 million gallons per day, or more than 20 turnovers of the pond per day. This assures that the temperature and the dissolved oxygen content of this pond is as good as it can be. The result is water that is effectively pre treated before going through the filtration and disinfection process. This aeration system substantially reduced the cost of the filtration and disinfection equipment due to the reduced loading and BOD of the water.

Step 2. Primary Water Filtration: Primary filtration of the pond water, to remove leaves, minnow, frogs, etc. is accomplished with six existing 42” Lakos shallow bed sand filters. Metrolina has replaced the sand in these filters with crushed glass media. This media allows these filters to provide finer filtration, down to about 70 microns; reduces backwash water by about 30% and eliminates the need to replace filter media in the future.

Step 3. Pre-Treatment Fine Filtration: From the pre-filtration, the next step of treatment is a set of two 96” diameter x 72” high deep media filters with crushed glass media. These filter out particulate down to 54 microns at about 95% efficiency. These filters are auto-backwashing, and backwash based on a specified time or hours of operation. Each filter can be backwashed independent of the other so there is never an interruption of flow.

Step 4. Ozone Contacting/disinfection: This is a custom built 96” pressure vessel with a baked on oxidation proof lining inside and out and it is where the primary disinfection takes place. From the 54 micron filtration, water flows into the top of the Ozone Contact Vessel while a stream of super ozonated water from the Ozone Generation skid is simultaneously circulated into the bottom of the Contact. Special patented plumbing in this vessel assures that the untreated water is contacted by, and thoroughly mixed with, the highly ozonated water, under pressure, to assure maximum disinfection. Ozone is the most powerful oxidizer available, working 3,100 times faster than chlorine and with 40,450 times more killing power, meaning that a very short contact time of only a moment is
required to be effective. The water is ozonated in the contact tank to a level sufficient to carry a high residual ORP, in the 500 to 600 mV range, back to the flood storage tank being treated.

Step 5. Ozone Generation: Adjacent to the Ozone Contacting vessel is a custom-built ozone generation skid. All of the components necessary to generate the correct amount of ozone, inject it into the contact tank water stream, and control the entire system are mounted on this stainless steel skid. Components include high end air compressor, medical quality oxygen generator, custom built corona discharge ozone generator, computer controls and touch screen interface.

Step 6. Post Treatment Fine Filtration: After leaving the contact tank the water flows through an additional set of two 90” diameter x 72” tall deep media crushed glass filters. These filters remove the solids such as iron, manganese and other residues that precipitate out during the intense oxidation process. This is also filtered again down to 5 microns. This is a final assurance that irrigation emitters, valves and filters will no longer be clogged. In addition to being a very powerful oxidizer, ozone also functions as a good broad-spectrum micro-flocculent pulling together particles for easier filtration.

Step 7. Flow Selection: After complete treatment a set of valves is used to either send the treated water to the MX2 production range, or to a 500,000 gallon tank that serves the young plant range and other areas.

Step 8. Recirculation Treatment: The water is treated continuously and when this 500,000 gallon tank is full the overflow from the tank flows at up to 200gpm back into the pond, where it started. This accomplishes two functions: 1) It keeps the water in the tank at a high ORP and dissolved oxygen level, which supplies the plants with the highest quality high DO water and also maintain the tank and irrigation lines free of biofilm. 2) It pre-treats the pond water by continuously feeding a supply of high ORP, high DO water into the pond to improve the water quality.

Glossary Of Terms

Aeration:
The process of introducing oxygen into a body of water or water stream, more specific to water treatment it is the homogenization of a body of water to assure the introduction of and thorough mixing of dissolved oxygen throughout the entire vertical column of water from the bottom of the pond to the surface.

Aerobic:
A process that takes place in the presence of oxygen, such as digestion of organic matter by bacteria in a pond.

Anaerobic:
A process that takes place in the absence of oxygen, such as the digestion that takes place in a Bio4 filter.

Anoxic:
A hypoxic zone in a body of water that has no or very little oxygen, generally with oxygen concentrations of less than 2ppm, a level generally considered as the minimum necessary to support life.
**Advanced Oxidation:**
One of several combination oxidation processes. Advanced chemical oxidation processes use (chemical) oxidants to reduce COD/BOD levels, and to remove both organic and oxidizable inorganic components. The processes can completely oxidize organic materials to carbon dioxide and water, although it is often not necessary to operate the processes to this level of treatment. UV and Ozone is an excellent Advanced Oxidation Process.

**Biochemical Oxygen Demand (BOD):**
The amount of oxygen (measured in mg/L) that is required for the decomposition of organic matter by single cell organisms, under test conditions. It is used to measure the amount of organic pollution in wastewater.

**Biofilm:**
Population of various microorganisms, trapped in a matrix or layer of slime and excretion products, attached to a surface such as an irrigation pipe, valve, emitter or any surface regularly exposed to free moisture.

**Bio-Filter:**
A unit in which anaerobic bacterial action is induced and accelerated in order to break down and stabilize organic matter removed from the treatment process.

**CFU:**
Colony Forming Units, a measure of the number of microorganisms in water or on surfaces.

**Chemical Oxygen Demand (COD):**
The amount of oxygen (measured in mg/L) that is consumed, in the oxidation of organic and oxidizable inorganic matter, under test conditions. It is used to measure the total amount of organic and inorganic pollution in wastewater. Contrary to BOD, with COD practically all compounds are fully oxidized.

**Contact Time (CT):**
The length of time a substance (pathogen) is in contact with an oxidizer or other chemical reducer for the occurrence of the chemical change or destruction.

**Deep Media Filtration:**
A media filter that is several feet deep (i.e. 48 to 72”), as opposed to 12”436” deep to increase the filtration capacity of efficiency of a media filter.

**Dissolved Oxygen (DO):**
The amount of oxygen dissolved in water, expressed in ppm or mg/L. The maximum solubility of DO in water at 70˚ F is 9 ppm.

**Eutrophication:**
Enrichment of water; causing excessive growth of aquatic plants and increasing activity of anaerobic microorganisms. As a result the oxygen levels in the water quickly decline and the water chokes, making life impossible for aerobic water organisms.

**Filter Efficiency:**
The percent of contaminant reduction which occurs with a specified medium volume and specified water contact time.
**Flocculation:**
The accumulation of destabilized particles to form a single larger mass called flocs, usually through chemical means called a flocculent.

**Ground Water:**
Water from a well or subsurface extraction.

**Hardness:**
Condition caused by dissolved salts of calcium, magnesium, and iron, such as bicarbonates, carbonates, sulfates, chlorides, and nitrates.

**Mesh size:**
Mesh is the number of openings in a square inch of a screen or sieve. It is equal to the square of the number of strands of metal or plastic screening per lineal inch.

**Micron:**
A metric unit of length equal to one millionth of a meter or one thousandth of a millimeter or about 0.00003937 inches. The symbol for micron is the Greek letter μ.

**Micron rating:**
A measurement applied to filters or filter media to indicate the particle size at which suspended solids above that size will be removed. As used in the water treatment industry standards, this may be an absolute rating or a nominal rating.

**Microorganism:**
A living organism invisible or barely visible to the naked eye and generally observed only through a microscope. Also called a microbe. Microorganisms are generally considered to include algae, bacteria, fungi, protozoa and viruses.

**Oxidizer:**
A chemical substance that gains electron (is reduced) and brings about the oxidation of other substances in chemical oxidation and reduction (redox) reactions.

**Oxidation Reduction Potential (ORP):**
The electric potential required to transfer electrons from the oxidant to the reductant, used as a qualitative measure of the state of oxidation in water treatment systems.

**Ozone (0₃):**
A very strong oxidizing agent which is unstable and must be generated on site. It consists of three oxygen atoms. Ozone is a highly reactive form of oxygen and can be produced by sending a high voltage electrical discharge through air or oxygen (such as occurs in a lightening storm). Ozone the most powerful oxidizing agent available.

**Pathogen:**
Any organism than can cause disease.

**Permeate:**
The “filtered” product/usable water from a Membrane Filtration system.

**PPM:**
Parts per Million, equal to milligrams per liter (mg/L)
Reverse Osmosis (RO):
A water treatment process that removes undesirable materials from water by using pressure to force the water molecules through a semipermeable membrane. This process is called "reverse" osmosis because the pressure forces the water to flow in the reverse direction (from the concentrated solution to the dilute solution) to the flow direction (from the dilute to the concentrated) in the process of natural osmosis. RO removes ionized salts, colloids and organic molecules down to a molecular weight of 100.

Surface Water:
Water from a stream, pond, river.

Total Suspended Solids (TSS):
The weight of all organic and inorganic solids in suspension (undissolved) per unit volume of water

Total Organic Carbons (TOC):
the total weight of organic carbon (decomposed plant and animal residues and microorganisms) in an organic compound, excluding inorganic carbons (minerals). Organic carbons can be reduced by oxidation.

Total Dissolved Solids (TDS):
The sum or all inorganic and organic particulate material, by weight, that are dissolved in the water, given in ppm per unit volume of water. There is a relationship between TDS and conductivity. TDS is an indicator test used for wastewater analysis and is also a measure of the mineral content of groundwater.

Understanding ORP & Ozone
ORP is Oxidation Reduction Potential, or sometimes known as Redox. ORP is simply an indicator or reflection of the "available oxidizer" in the water. Note that it is not a measure of the level of the oxidizer itself, but it is broadly used in water treatment as a very reliable and universal measure of the oxidizing potential of the water at the point of measurement. The oxidizer can be Oxygen, Chlorine, Peroxide, Ozone, or any other oxidizer.

ORP readings are expressed in milli volts (mV). The full range of readings indicating oxidation potential is from -2000 to a +2000 mV. Most ORP meters indicate a range from -1200 to +1200 mV and this is entirely adequate for water treatment purposes. A reading above 0 mV indicates there energy available to oxidize, e.g. give up or impart a molecule to an element which can be reduced or accept an O molecule decreasing it's oxidation state.

If you have one molecule of ozone it will either react with a contaminant or organism or convert back to O2. If it collides with an organism before it bumps into an oxidizable contaminant, then it will kill the organism, therefore it is disinfecting. With chemicals, such as Chlorine, it is more complicated and less predictable since these chemicals react so much slower than ozone with organisms making them much more likely to react with a contaminant first. Additionally, with many chemicals, the pH level of the water is much more critical in their reaction.

If there are available oxidizers (indicated by a positive ORP) in the water, given enough time and contacting, they will react with something or degrade. Of course the more available oxidizer you have (concentration) the more contaminants or organisms it can react with, creating more effective disinfection or oxidation. As the available oxidizer level increases the more likely it will react with a greater percentage of the contaminants and organisms. The predictability is largely dependent upon
effective mixing, but also upon temperature since the warmer the water the faster the molecules are moving around, making them more likely to collide with contaminants or organisms. There are many other factors which effect different chemical oxidizers as well, such as turbulence, light levels, etc.

An additional advantage of ozone as an oxidizer is that ozone goes through a free radical phase as it converts back to oxygen. This free radical is the most reactive oxidizer possible and has tremendous disinfection capability. This reaction occurs in fractions of a second so the more ozone there is in solution the more free radicals will be available at any moment. Energy is what makes ozone release its third molecule of Oxygen creating the radical so if UV3 (ultraviolet light) light energy, or hydrogen peroxide is added to the solution, all the ozone converts at once forming a solution with the greatest number of free radicals possible and the greatest potential of reacting with the most contaminants or organisms.

ORP readings in most homes on municipal water systems in the US will average in the 200-300 mV range. This water has been disinfected, but its disinfecting capacity is low. A 650 mV reading in a water treatment system indicates that, essentially, any oxidizable contaminant entering the water will be killed. So it is most important to know the ORP reading is in the reaction chamber or contact tank, since this is where the most of the actual disinfection takes place. Once you clean up the water any positive oxygen level is quite effective at maintaining clean water.

The goal is to disinfect the water at the point of reaction or contacting then keep it in a state which is healthy to plants, people and animals…not to keep a toxic level in the water all the way to the root zone of the plant which is not healthy for the plant.

The water treatment system will accomplish 3 primary water treatment objectives:

1. Eliminate water borne pathogens in source water.
2. Eradicate biofilm in the irrigation distribution and delivery systems.
3. Create very high dissolved oxygen (DO) levels in the irrigation water.

Objectives 1 and 2 assure the necessary function of achieving a dramatic reduction or elimination of diseases resulting from water borne pathogens. Objective 3 substantially increases the dissolved oxygen levels in the root zone resulting in significant benefits beyond disinfection and biofilm eradication helping to bring your production to the next level of profitability.

Below are several key benefits reported by growers with this irrigation system. Most of these are reported to us as anecdotal observations, and some have been observed in side-by-side trials and experiments. In any case your results will be as unique as your water quality, crops, facility, and growing style. We cannot of course guarantee the extent of improvements you will experience but we are our many years of experience with these systems in animal and greenhouses agriculture make us completely confident that you will see similarly beneficial results.

The accumulated benefits of the high quality water are able to recover the system investments in as little as a year, and may cover the amortized capital and annual operating cost immediately.

Quantifiable benefits and reported ranges of improvement:

- 75-95% reduction in plants lost due to clogged drippers
- 30-50% reduction in labor for clogged dripper scouting
- 75-95% reduction in material and labor to replace clogged drippers
• 75-95% reduction in plants lost due to clogged drippers
• 50-95% reduction in plants lost to root disease caused by water borne pathogens.
• 10-30% higher seedling success rate from germination first root/radicle establishment
• 10-25% higher successful rooting of cuttings and transplants
• 9-23% faster plug production time (seed drop to transplant, 4-10 days depending on crop)
• 3 to 10 days shorter production (rooting to finishing) time depending on crop.
• 100% elimination of Birm media consumable and replacement labor for iron removal filters
• 20% to 75% lower fungicide application due to lower disease pressure and improved plant health and disease resistance/defense.
• 5-20% lower fertilizer use due to improved nutrient uptake and conversion
• 20-80% lower algaecide use resulting from lower algae population from biofilm
• Reduced plant damage in shipping and handling due to thicker stem caliper and larger root system. (no specific percentages reported)
• Higher sell through due to up to 1 week extended shelf life and higher grade/quality at retail due to less root disease, improved plant health and disease resistance, and more efficient water uptake.
• Reduced production and post-production shrink due to secondary infections and pest pressure resulting from improved plant health and resistance.

Lighting

Greengro markets the industry's most advanced LED grow lighting technology at the best prices. The company is an exclusive distributor for leading lighting companies and an authority on light-emitting diode (LED) systems used in greenhouse installations, building retrofits, and other lighting applications.

LED grow lighting uses a semiconductor light source that works across the visible, ultraviolet, and infrared wavelengths to project very high brightness.

These lighting systems use low voltage DC power supplies and microgrids making them highly reliable, and independent of the grid. These systems are compatible with renewable energy sources such as solar, creating a clean, low cost an intelligent distributed power future.