Shallow Geothermal Earth to Air Heat Exchanger (EAHX) Retrofit Heating and Cooling System Install Info Sheet

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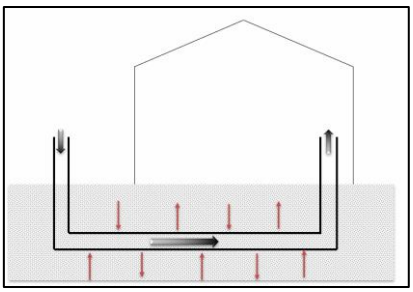
This info sheet details some key information and installation considerations for EAHX systems for season extension in high tunnels. The information and cost estimates are based on our experiences in installing a 60' EAHX system as a retrofit in the 30x96' high tunnel at Oaks and Sprouts Limited in December 2022. We believe these systems have potential for wider adoption to extend seasons and increase profitability while minimizing fossil fuel dependence.

Introduction to Shallow Geothermal Resources

Unlike deep geothermal resources that are limited to certain geographical regions and require specialized machinery to access high temperature reservoirs hundreds of feet under the earth's surface, shallow geothermal resources rely on the insulating properties of just a few feet of soil. The soil is insulated, but the temperature shifts throughout the year due to seasonal changes. Under the surface, soil is cooler than outside air in the summer, and the long hot days may 'recharge' the thermal battery of the soil so that the underground temperatures are warmer than outside air through fall. Because of these seasonal changes, shallow geothermal provides both cooling and heating relative to outside temperatures at different parts of the year.

Earth-to-Air Heat Exchangers (EAHX) for Heating and Cooling



The temperature difference between soil and outside air can be harnessed through using a heat exchanger. Heat exchanger systems rely on circulating a fluid through a large surface area at a higher or lower temperature so that heat can be transferred. An earth-to-air heat exchanger is a simple form of heat exchanger, using the same air to exchange heat with the soil that is then circulated through the building. An earth-to-air heat exchanger only has one active component, the fan pulling air through the system and pushing it into the high tunnel. These systems are also called earth tubes, cooling tubes, or ground source heat exchangers.

Installation Considerations

Moisture exclusion: Be careful of mold-promoting conditions that could develop in the tubing, either due to water intrusion or natural condensation. Control for moisture by securing every connection in the piping, using solid (non-perforated) piping, and planning for moisture removal by installing a pump access point at the low point of the system. Still, because of the risks associated with mold or bacteria growth, use an EAHX in conjunction with plenty of fresh air ventilation.

Pest exclusion: It is a good idea to secure pipe openings against any bugs or larger pests who may try to move in. Wire mesh can be used, but we have noticed that pollen, bugs, and other materials can build up on the surface, similar to a lint trap in your clothes dryer. This makes your fan work harder, so clean off the mesh surface regularly.
Follow applicable regulations: Always call 811 before you dig and follow all relevant local regulations and requirements before performing an excavation. Caution: trenches deeper than 4' pose a potential hazard from the collapse of the earth walls on workers. Follow the required code and only attempt electrical work that you can safely and legally perform in your zoning and skill level.
Controls: Because of the seasonality of the soil temperature that the EAHX relies on, it is beneficial to include thermostat control of the EAHX fan. A humidistat control can also turn off the EAHX when it is raining or high humidity conditions outside.

Cost of Installation at Oaks and Sprouts

Items	Cost
Specialty supplies, including in-line fan (754 cfm max), specialty duct reducers, and large hose clamps	$670
Off the shelf supplies: corrugated and PVC pipes, fittings, hardware	$690
Labor and Equipment: Backhoe for one half-day	$500
Provided by Oaks and Sprouts – sacrificial lumber, 6” duct fittings, small hardware, wiring supplies	$300 (est)
Total	$2,160

Observed Benefits of EAHX

Cooling: provided cooler air than ventilation alone in hottest summer months. Compared to outside weather conditions, cooling capacity up to ¼ ton air conditioner.
Heating: delayed use of propane heater in fall – offset 5.5 gallons propane in first two weeks of Fall 2023.

Appendix – Key Installation Details:

Tools

Project	**Tools**
Trench	Spade shovel, cutter mattock, spud bar
Electrical	Standard electrical toolkit. Follow the required code and only attempt electrical work that you can safely and legally perform in your zoning and skill level.
HVAC	Impact driver and with bits, drill with associated bits, scissors, straight-cut aviation snips, ladder, metal chop saw, ratchet set.
Pipe Fitting	Impact driver with associated bits, sharp scissors for pipe tape, 6’ level, reciprocating saw and/or PVC hack saw.
PPE	Cut resistant gloves, disposable gloves, safety glasses, caution tape and safety cones for trench perimeter.

Materials – Underground System:

Corrugated Pipe: 6” solid corrugated pipe was purchased in a roll of 100’ feet. We wanted non-perforated pipes to protect against water intrusion. The 6” size was the largest available from local hardware stores, and the larger size allows more air to flow through the system and exchange heat.

CPVC Pipe: Sewer/drain type PVC pipe was used for the risers of the EAHX system.

Connections: Multiple methods were used to ensure watertight connections:

Corrugated pipe internal couplers (Figure 1) are designed to connect two corrugate pipes, but can be friction fit into the right size PVC pipe.

Moisture resistant pipe wrap tape or ‘tile tape’ (Figure 2) was wrapped several times over the coupler connection point.

Finally, a 6” rubber flexible coupling was secured over the wrap point.

Fittings: To protect against water intrusion from rain, a 90° elbow, short run of pipe, and a 45° elbow were attached to the riser PVC pipe so the opening would be angled down (Figure 3).

To protect against pest intrusion at intake, fine wire mesh was secured around the intake opening with a length of hanging strap wrapped around the outside of the PVC and secured with self-tapping screws (Figure 3).

At the ground level, the riser was cut, and a wye was installed and fitted with a cleanout adapter and sewer cleanout plug.

Figure 1 Corrugated connection and flexible coupler

Figure 2 Pipe wrap or 'tile tape' before rubber coupler is slid into place

Figure 3 EAHX Intake Riser with wye at ground level and elbows and mesh at intake. Note supporting lumber before backfilling

Materials – Connecting to High Tunnel

Fan support: The fan was mounted on a strut which was secured with two points of contact to a support beam of the high tunnel.

Brackets were secured around the high tunnel support with self-tapping metal screws.

A threaded rod was attached to the brackets with an I-bolt and threaded rod coupler. The threaded rod was secured to the strut with strut channel cone nuts. This set-up gave some flexibility in adjusting the strut to a level position before the fan was mounted (Fig 3).

Figure 4 Strut secured to high tunnel with bracket

Pipe meetup: A sloped trench was hand-dug under the base of the high tunnel to meet up with the underground EAHX system components. A 45º PVC elbow facilitated the connection between the vertical fan mount and the underground system (Fig 5).

Figure 5 Connecting underground system to fan

Air distribution: A duct boot at the top of the system directs air from the EAHX system towards the nearest circulation fan. A few flex duct elbows were needed to match the curvature of the high tunnel and keep the ductwork out of workspace as much as possible. Large size hose clamps were used to secure the ductwork to high tunnel supports. Specialty duct reducers were used to convert between the diameters of the PVC pipe, the fan, and the ductwork (Fig 6).

Additional wire mesh was secured around the duct outlet with hanging strap and screws.

Figure 6 Air distribution ductwork

Materials - Electric:

- Schedule 40 Conduit and conduit elbows as needed
- 20 Amp Single-Pole Plug-On Neutral Dual Function Circuit Breaker
- 12 AWG THHN Solid Core Stranded Wire
- Wiring supplies (ex. wire nuts, electrical PVC glue, PVC terminal adapters and parts, light switch, outdoor rated light switch box and cover).

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