

# A Guide to Energy Savings for Greenhouses

Best practices and most efficient technologies to extend the Vermont growing season.

Vermont farmers use different strategies to extend their growing season or get a head start on Spring. Growing locally in colder months requires greenhouses. If the greenhouse is heated or lit, energy consumption is the grower's largest overhead cost. Greenhouses are typically heated with oil or propane, and lit with energy-intensive grow lights. So, even our locally grown food and products can have a large energy/carbon footprint. There are seven main considerations to saving energy and reducing carbon emissions in a greenhouse, including the house envelope, power capacity, heating systems, lighting, controls, ventilation and dehumidification, and irrigation. Energy-efficient improvements can help lower operating costs, boost profitability, and increase yields.

## Reduce Heat Loss in Your Greenhouse

Reducing air leaks, insulating the edges, using thermal curtains, and installing in-ground heating are the top strategies for saving energy while maintaining the best possible growing conditions in your greenhouse.

- Stop leaks: Weather-strip doors and install door closers. Check for obstructions or leaks around vents and lubricate fan shutters. Install one-inch thick polystyrene or polyurethane insulation board to a depth of 18" – 24" below grade at the edge of the greenhouse for insulation.
- Thermal curtains: Install thermal curtains to reduce thermal heat loss at night or use them for shading in the summer months to reduce cooling loads. To be most effective, curtains should be in good operating condition, sealed around edges, free from rips and holes, and ideally, connected with a controller. Simple payback can range from six months to five years.
- In-ground heating: Install radiant hot water beneath or at the ground level to focus heat where it's most effective. Root zone temperature is more critical than leaf temperature in achieving good plant growth. If the optimum root zone temperature is maintained, then air temperature in the greenhouse can be 5 – 10 degrees lower.
- Replace your coverings: Replacing your polyethylene or polycarbonate can help you reduce heat loss by about 50%.
- Replace your coverings: Use an infrared inhibitor (IR) and anti-condensation film on the inner layer of your greenhouse walls and ceilings for 12 - 15% heat loss savings.

**\$** Rebates are available for thermal envelope upgrades.



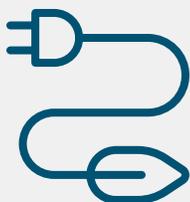


## Switch Heating Systems to Lower Carbon Impact

Conventional heating systems in greenhouses use fossil fuels like propane and oil. There are other options that can save money, have lower carbon impacts, improve operations, and include a rebate.

- Wood furnaces and boilers have become much more efficient in the past few years. These systems are a good option for sustainably heating your greenhouse space.
- Ground-source heat pumps (GSHP) can provide constant efficient heat. These systems have expensive upfront installation costs. However, if you're already excavating, this could be an ideal time to consider a GSHP at a lower cost.
- Air-source heat pumps are an efficient heating technology, but may require a fossil-fuel backup for extremely cold temperatures, power outages, and general redundancy. For certain models, ROI can be as little as one and a half to four years.
- Hydronic heating under benches and below-ground benefits plants and allows air temperature to be 5-10 degrees lower. This can reduce unit heater cost by 20-25% and have a simple payback of one to five years.

**\$ Rebates and custom incentives are available. In addition to Efficiency Vermont rebates, your electric utility can support measures that offset fossil fuels.**



## Consider Power Needs of Your Greenhouse

If you switch from a fossil fuel to electric power, consider what kind of power capacity you will need.

- Contact your electric utility to review requirements, and stay in touch to learn about rate options, potential rebates, and programs that might help offset investment and operating costs. Electric utilities can provide support towards the electrification of your greenhouse.
- Talk to your electrician about how much energy you are currently using and how much you plan to use. You may need an electrical panel upgrade (for home grow setups) or 3-phase power (for commercial facilities) to run certain equipment, which will be important to consider before purchasing new equipment. Your electric utility can help you determine whether a 3-phase line extension is cost-effective for you.



## Optimize Lighting to Save Energy

Supplemental grow lighting has become more popular over the years and tends to be the largest electrical load in a greenhouse during the winter.

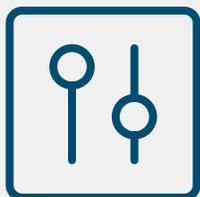
If you are supplementing, consider LED lighting:

- Use less wattage than a typical High-Pressure Sodium (HPS) light; for example, an LED with the same or more photons, may use 650W while an HPS may use 1000W.
- Run cooler than HPS and other technologies-this means savings on your fan or cooling power
- Directional by nature, they can have good canopy penetration
- Can provide adequate light intensity (PPFD -- photosynthetic photon flux density) for plants

- Select products can be dimmed or color-tuned, allowing you to adjust to plant needs at each stage of growth.
- Small LED form factors available reduce shade from natural daylight penetration
- Last 2-5 times longer than other technologies
- Can be cycled on and off without lowering the life

As every project is different, there may be other comprehensive solutions that are right for you. Rebates are available for LED fixtures on our Qualified Product List. In some cases, your electric utility may offer additional incentives on High Pressure Sodium lights, and other measures that can help reduce fossil fuel consumption, and associated energy costs. If you do not see a product on the Efficiency Vermont qualified products list, please call us to ask about custom qualification.

**\$ Rebates and custom incentives are available for supplemental lighting. In addition to Efficiency Vermont rebates, your electric utility can support measures that offset fossil fuels.**



## Use Controls to Automate & Monitor

Controls help you reduce operating costs by automating and recording technologies and conditions. Temperature, irrigation, lighting, humidity, CO<sub>2</sub>, and ventilation are important to control for consistent crop productivity and to balance extreme weather conditions.

Consider the following best practices for controls in your greenhouse:

- Replace old thermostats with digital programmable thermostats intended for agriculture use.
- Use controls to check conditions, to see how heating, lighting, and ventilation may be interacting, and to adjust settings as needed.
- Take advantage of utility time-of-use rates, under which you can save money by operating equipment at certain times of the day when electricity is less expensive. Reduce peak electricity usage by using controls to ramp HVAC and lighting up and down.

**\$ Rebates are available for greenhouse controls.**



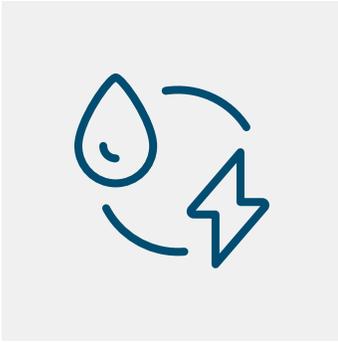
## Be Mindful of Airflow and Humidity in the Greenhouse

Achieving and maintaining proper relative humidity (RH) levels is important for crop growth and health. Air flow is important to reduce negative impacts from pests, mold, mildew, and fungi.

Consider the following best practices for ventilation and dehumidification:

- Vent naturally in warmer months when possible.
- Use exhaust/circulation fans designed specifically for agriculture use and heat recovery ventilators.

**\$ Rebates are available on ENERGY STAR dehumidifiers and agricultural fans.**



## Optimize Irrigation Systems to Save Energy

Pumping systems that support greenhouse spaces can be optimized to use the smallest amount of energy.

- Irrigation pumps should be appropriately sized for the system and for the amount of water used.
- Use variable frequency drives (VFDs) on pumps to save energy by adjusting the speed and flow to match the work being performed.

 **Rebates are available for VFDs.**

## Call Efficiency Vermont Today

It's time to improve your bottom line by eliminating unnecessary energy waste in your greenhouse. Take advantage of available discounts and rebates offered by Efficiency Vermont and Vermont electric utilities. Efficiency Vermont customer support can help with your energy saving goals. **Call us to learn about rebates, custom incentives, qualified contractors, and even financing!** New Construction projects are also eligible for rebates. Find an Efficiency Excellence Network member by visiting [www.encyvermont.com/contractor](http://www.encyvermont.com/contractor).

## Sources

Energy Trust of Oregon

John Bartok in 2003, 2009, 2013, 2015, UCONN

Visit [www.encyvermont.com/rebates](http://www.encyvermont.com/rebates) for current rebate offers and Qualifying Products lists.

**In support of lowering Vermont's green house gas emissions, rebates are brought to you in partnership by:**



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