



PRESENTED BY GDS ASSOCIATES, INC.

# BEST PRACTICES FOR ENERGY EFFICIENCY

*Greenhouse and Controlled Environment Agriculture*

Agriculture Solutions Fair, SUNY Cobleskill

February 16, 2024

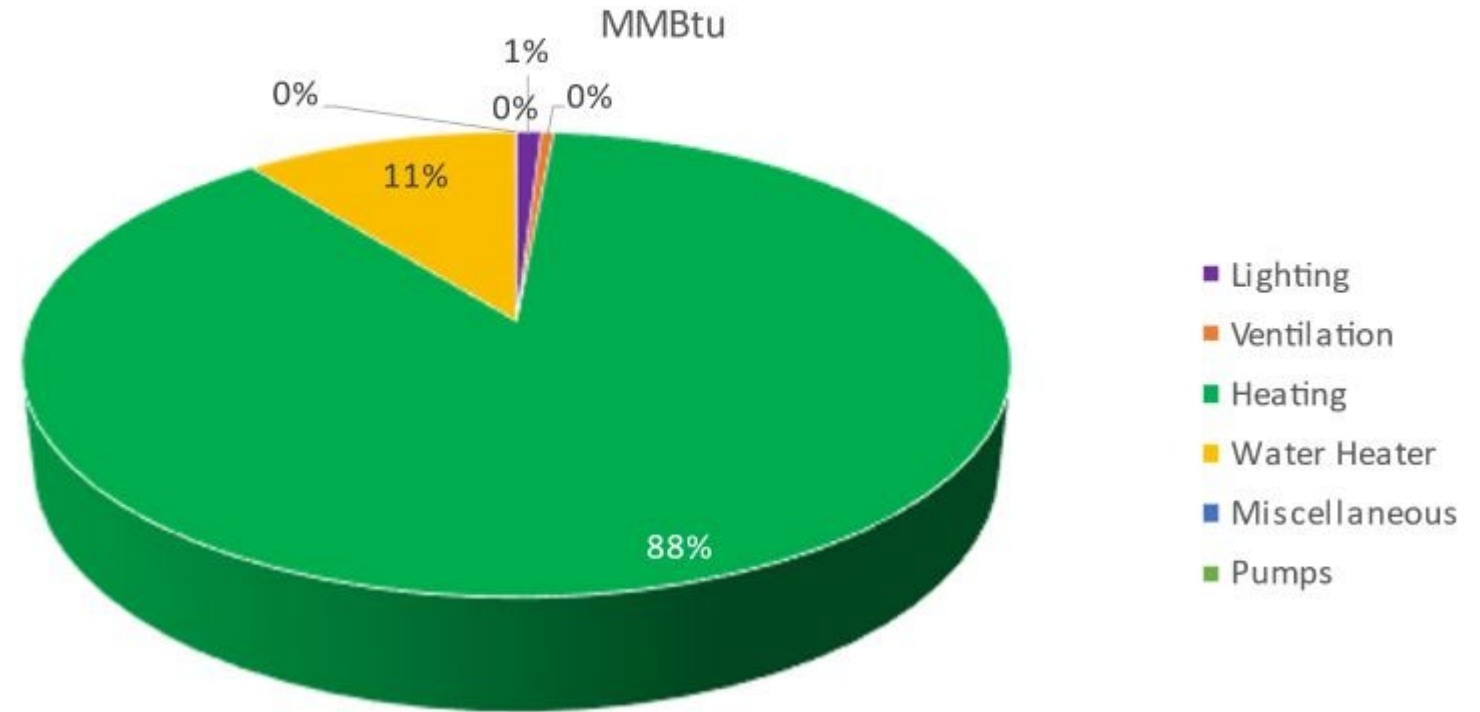
# — WHY GROW INDOORS?

- Complete control of growing conditions
- Year round growing of crops
- Demand for local food
- Increasing population
- 80% of arable land is in use

# CHALLENGES OF GROWING INDOORS

- ❑ Can be energy intensive
- ❑ Energy costs can strain business

Breakdown of Energy Use in Greenhouses

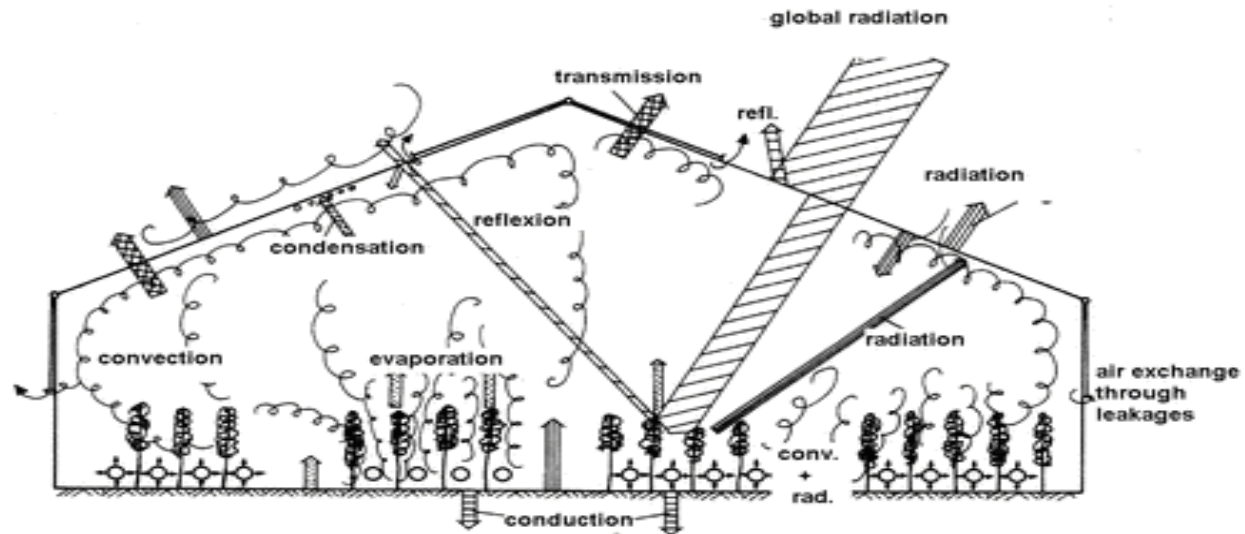


Source: Aluel Go, unpublished data from Michigan Farm Energy Program. 2021, [How do I use less energy to heat my greenhouse?](#)



# GREENHOUSE ENERGY BREAKDOWN

- Besides labor, energy costs are the largest cost for a greenhouse:
  - 70-80% heating
  - 10-15% cooling
- Energy usage varies by purpose of a greenhouse



# ENERGY EFFICIENCY - GREENHOUSES

- High efficiency heating
- High efficiency cooling
- Thermal curtains/shade curtains
- Insulation/glazing
- LED lighting/grow lights

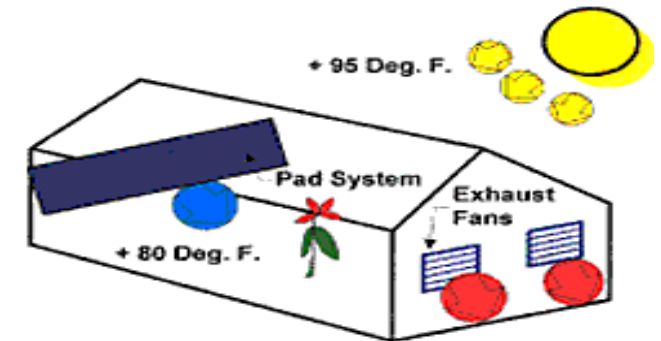
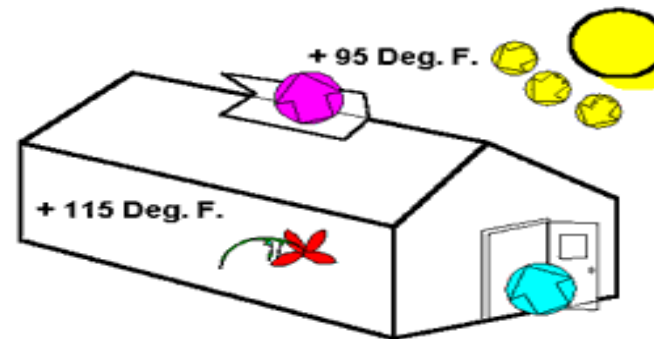
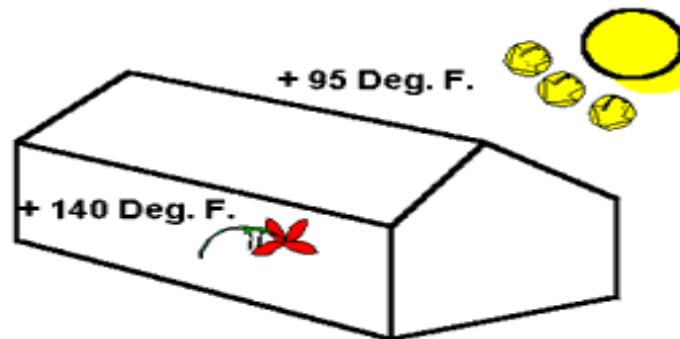
# HEATING

- ❑ **Root zone heating**
  - *lower heating costs by 20-25%*
  - *Reduce air temperature by up to 15°F*
  - *Infloor or under bench*
- ❑ **HE boiler – can be over 95% efficient**
- ❑ **Condensing unit heater – 92% efficient**



# COOLING

- ❑ Natural ventilation – ridge and side vents
- ❑ Shade curtains (may double as thermal curtain)
- ❑ High efficiency fans
- ❑ Fogging



# THERMAL CURTAIN

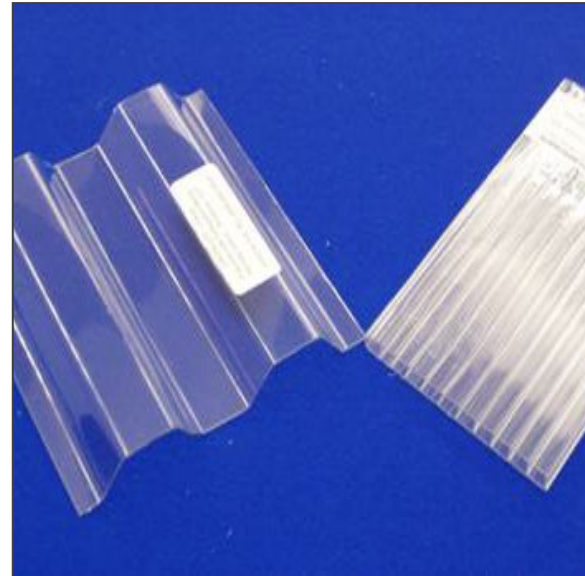


- ❑ 80% of greenhouse heating is at night
- ❑ Reduce night heating up to 50%
- ❑ Must seal to prevent chimney effect
- ❑ Can double as shade curtain
- ❑ Automated or manual control



# INSULATION/GLAZING

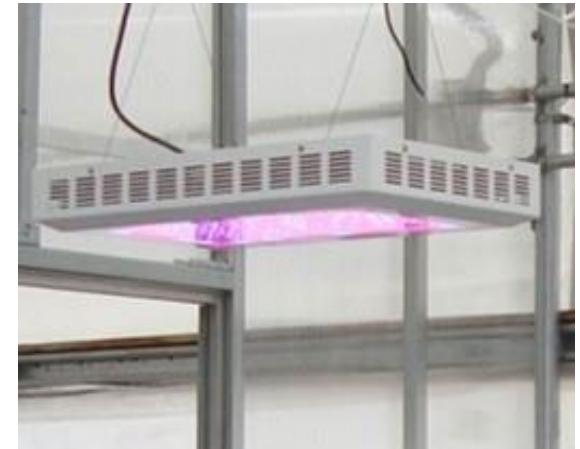
- ❑ High efficiency glazing – double poly IR film, triple polycarbonate
- ❑ Insulation – north end walls and knee walls
- ❑ Insulation – perimeter, 4' deep or 8' horizontally



# LIGHTING

## □ LED lighting

- *~35% savings over high pressure sodium (HPS)*
- *Select based on crop/cultivar/life cycle*
- *Dimming*
- *Daylight controls*



# ENERGY EFFICIENCY FULLY ENCLOSED BUILDING

- LED lighting/grow lights
- HVAC
- Dehumidification

# LIGHTING

- ❑ Choice of lighting will influence choice of HVAC and dehumidification equipment
- ❑ LED can save about 35% over HPS
- ❑ Verify efficiency and efficacy with Horticulture DLC website



Dallas HopWorks

# HVAC

- ❑ Heat recovery and economizers
- ❑ Heat pumps
- ❑ HE boilers
- ❑ HE chillers
- ❑ Hot gas reheat
- ❑ Hydronic systems
- ❑ Variable refrigerant system (VRF/VRV)
- ❑ Free cooling
- ❑ All systems must work in unison



# DEHUMIDIFICATION

- ❑ EnergyStar if residential unit
- ❑ Commercial high efficiency unit – specifically for CEA
  - *Stand alone units*
  - *Integrated units*



# ENERGY EFFICIENCY – ALL INDOOR AG

- Controls
- Irrigation
- Refrigeration

# CONTROL SYSTEMS

- **Must account for**
  - *Temperature*
  - *Humidity*
  - *Lighting*
  - *CO<sub>2</sub>*
  - *Weather*
- **Optimize specific plant parameters**
- **Change one parameter at a time**





# IRRIGATION

- ❑ Micro irrigation
- ❑ Root zone via flood trays
- ❑ Moisture sensors
- ❑ Integrate fertigation and chemigation



# REFRIGERATION

- ❑ EC motors
- ❑ Evaporator fan controls
- ❑ Insulation
- ❑ High efficiency compressors



# — GLENS FALLS URBAN AG PROJECT - GOALS

- ❑ **Develop self contained, easily replicable, scalable, transferable vertical farming system**
- ❑ **Grow wide variety of vegetables, herbs, and plants at site independent locations year round**
- ❑ **Create a business model that can easily be adapted to various sizes and styles of buildings with minimal alteration**
- ❑ **Find an innovative way to repurpose unused downtown spaces**
- ❑ **Find opportunities to automate as much as possible to decrease need to hire hard to find labor**

# — GLENS FALLS ENERGY EFFICIENCY MEASURES

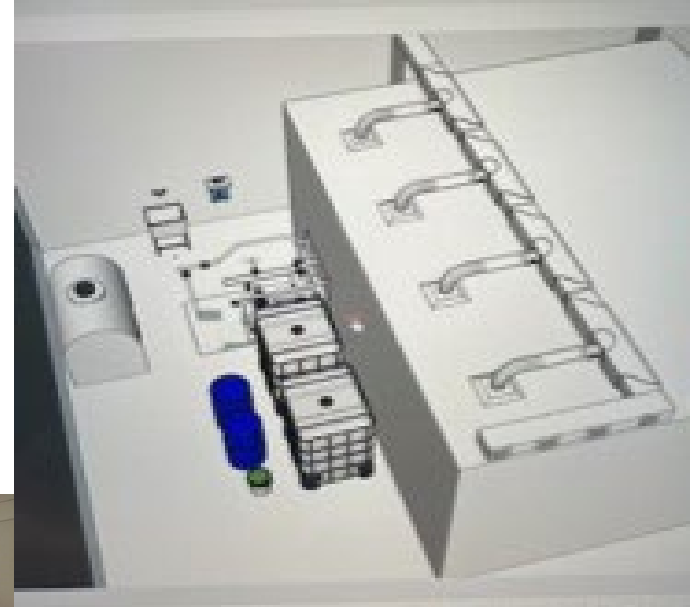
- LED grow lights
- High efficiency stand alone dehumidification
- Heat pump
- eGauge monitoring system
- Controls
  - Trolmaster Hydro X and Trolmaster Aqua X - control/monitoring of mini split, dehumidifier, pump, solenoids, and lights
  - Nuravine Aurora - control pH/ec
  - Cameras on crops

# — GLENS FALLS GRANT OPPORTUNITIES

- **National Grid incentives for**
  - *LED grow lights*
  - *Heat pump*
  - *High efficiency dehumidification*
  - *eGauge monitoring*



# — GLENS FALLS UAP – A BOX IN A BOX



# GLENS FALLS UAP – HIGH EFFICIENCY HEAT PUMP

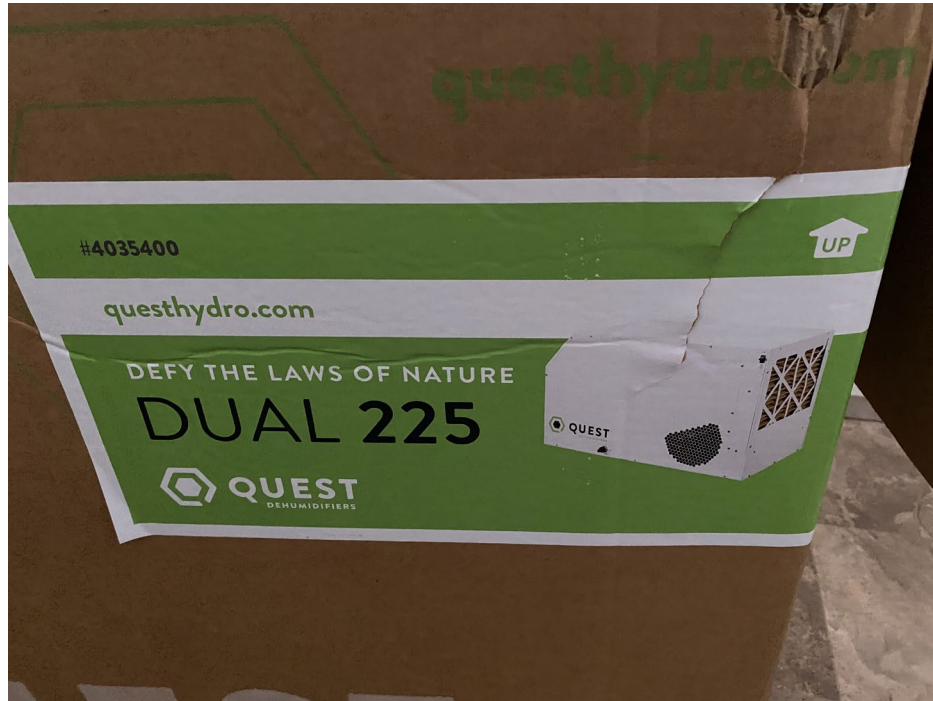


# GLENS FALLS UAP – DLC LISTED LED GROW LIGHTS

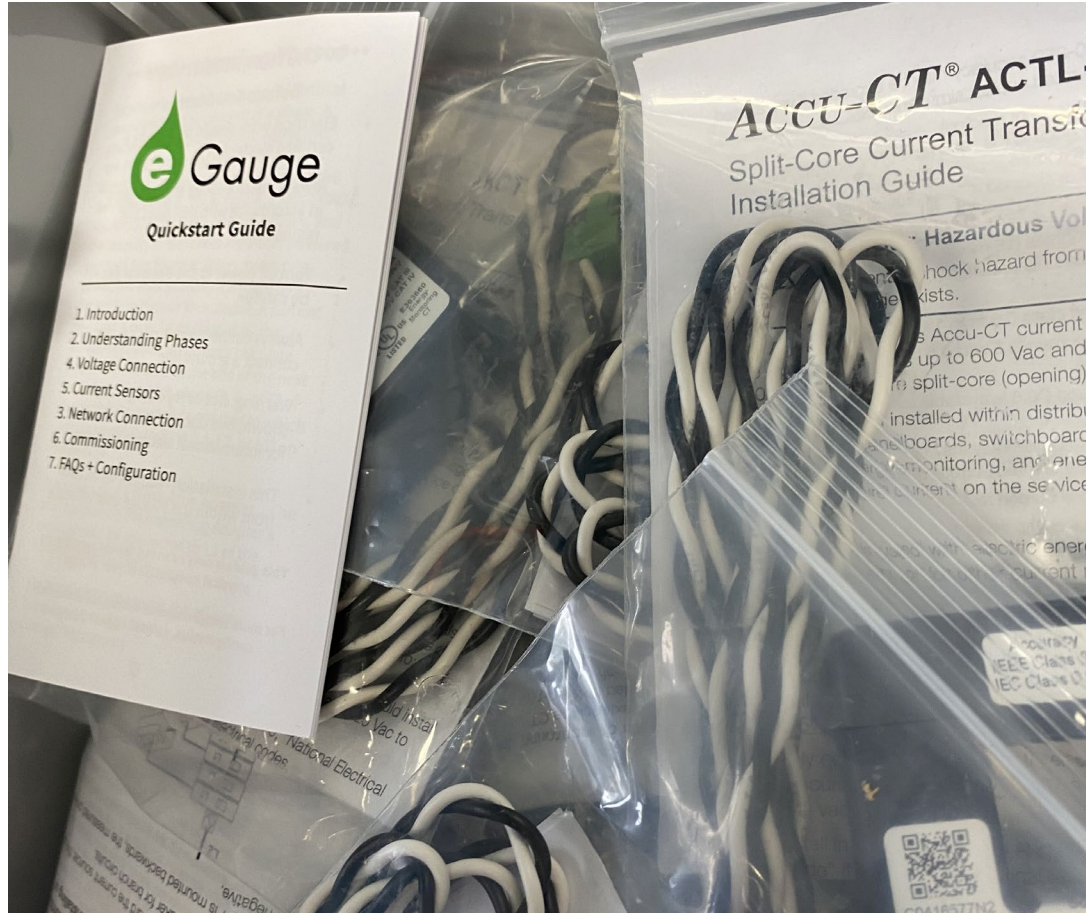




# GLENS FALLS UAP – HIGH EFFICIENCY DEHUMIDIFICATION



# GLENS FALLS UAP – ENERGY MONITORING



# GLENS FALLS ENERGY SAVINGS

Measure	Total Cost	Annual Electric Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)	Cost Savings	Simple Payback (Years)	Measure Life (Years)
<b>ECM-1: Lighting</b>	\$18,320	12,777	3.18	3.18	\$2,364	7.7	13
<b>ECM-2: Dehumidification</b>	\$6,300	2,623	0.30	0.30	\$485	13	15
<b>ECM-3: HVAC</b>	\$4,000	3,803	1.42	0.51	\$703	5.7	15
<b>Total</b>	\$28,620	19,203	4.90	4.00	\$3,552	8.1	-

# THANK YOU

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