Energy Savings of Evaporative Cooler Vent Covers at Orchard Park

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Introduction

Many of the greenhouses at Orchard Park are outdated and lack vent covers. The absence of vent covers allows heated air to escape the greenhouse at night, which severely lowers the heating and energy efficiencies of the facility.

The managers have received a $2 million grant for design adjustments and construction. Our team has partnered with them to investigate the economic feasibility of installing vent covers in order to better inform their spending.

Objectives

- Reduce energy usage and increase heating efficiency by preventing heated air from escaping via cooler vents
- Support both UC Davis research mission and Sustainable 2nd Century initiative
- Inform grant spending for greenhouse upgrades

Methodology

Following a literature review, data was collected and analyzed for 2 structurally comparable greenhouses: one with a vent cover (GH607), and one without (GH608). A month’s worth of temperature and hot water heating data was salvaged and used with infrared images in an attempt to estimate the difference in energy use between the two.

Ultimately, this data was deemed incomparable for further analysis.

As a result, a heat loss equation was used to calculate the theoretical energy savings. Using the energy savings, a simple payback period was calculated using a contractor quote and a rough estimation of installation and labor costs for the overall project.

Theoretical Airflow Model

Using an constant internal temperature of 25°C and meteorological data for Davis¹, an empirical equation² for calculating airflow through the vent was used to model the system. There are two main contributors to the loss of conditioned air:

1. Stack effects - driven by temperature difference between the greenhouse interior and exterior.
2. Wind driven infiltration - driven by exterior wind through gaps in envelope.

The theoretical flow rate was used to estimate the heat losses of the open system (no vent cover), and combined with UCD utility rates of 80% efficiency to calculate potential energy savings per greenhouse.

Results

Monthly & Annual Energy Savings:

Using the heat equation, estimated monthly savings vary from $72 to $233 depending on monthly heating necessities. The total annual savings estimate is $1,585.

The amount of savings depends heavily on average wind speeds and night-time exterior temperatures, which are both included in the theoretical model.

Table 1: Projected Savings Over Project Lifetime

<table>
<thead>
<tr>
<th>Greenhouse</th>
<th>Energy Savings</th>
<th>Project Cost</th>
<th>Total Savings</th>
<th>Rate of Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$109,355</td>
<td>$233,220</td>
<td>$123,865</td>
<td>53%</td>
</tr>
<tr>
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<td>$218,710</td>
<td>$233,220</td>
<td>$44,510</td>
<td>13%</td>
</tr>
<tr>
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<td>$233,220</td>
<td>$94,845</td>
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</tr>
<tr>
<td>4</td>
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<td>$313,555</td>
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</tr>
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<td>$233,220</td>
<td>$522,650</td>
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<tr>
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<td>$750,976</td>
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<td>7</td>
<td>$1,593,351</td>
<td>$233,220</td>
<td>$109,355</td>
<td>69%</td>
</tr>
</tbody>
</table>

Projected Savings for Payback Period:

Installation and labor costs were estimated to be 30% of the vent cover cost, resulting in a price tag of $3,380 per vent cover. A breakeven point is reached after 2 years of vent cover use.

This analysis assumes that energy rates do not change and if they increase, energy savings will proportionally increase.

Summary of Deliverables

- Annual Energy Savings*: $1,585
- Installation Cost*: $3,380
- Payback Period: 2.1 years

Conclusions

There is potential for over $1 million in energy savings with a 369% rate of return over a 10 year lifetime for 69 greenhouses. Saving potential and feasibility of installation depends on lifetime of project, therefore:

We recommend the installation of vent covers on any greenhouses with a 3+ year lifespan.

Acknowledgements

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