

Energy Efficiency in Lab Incubators



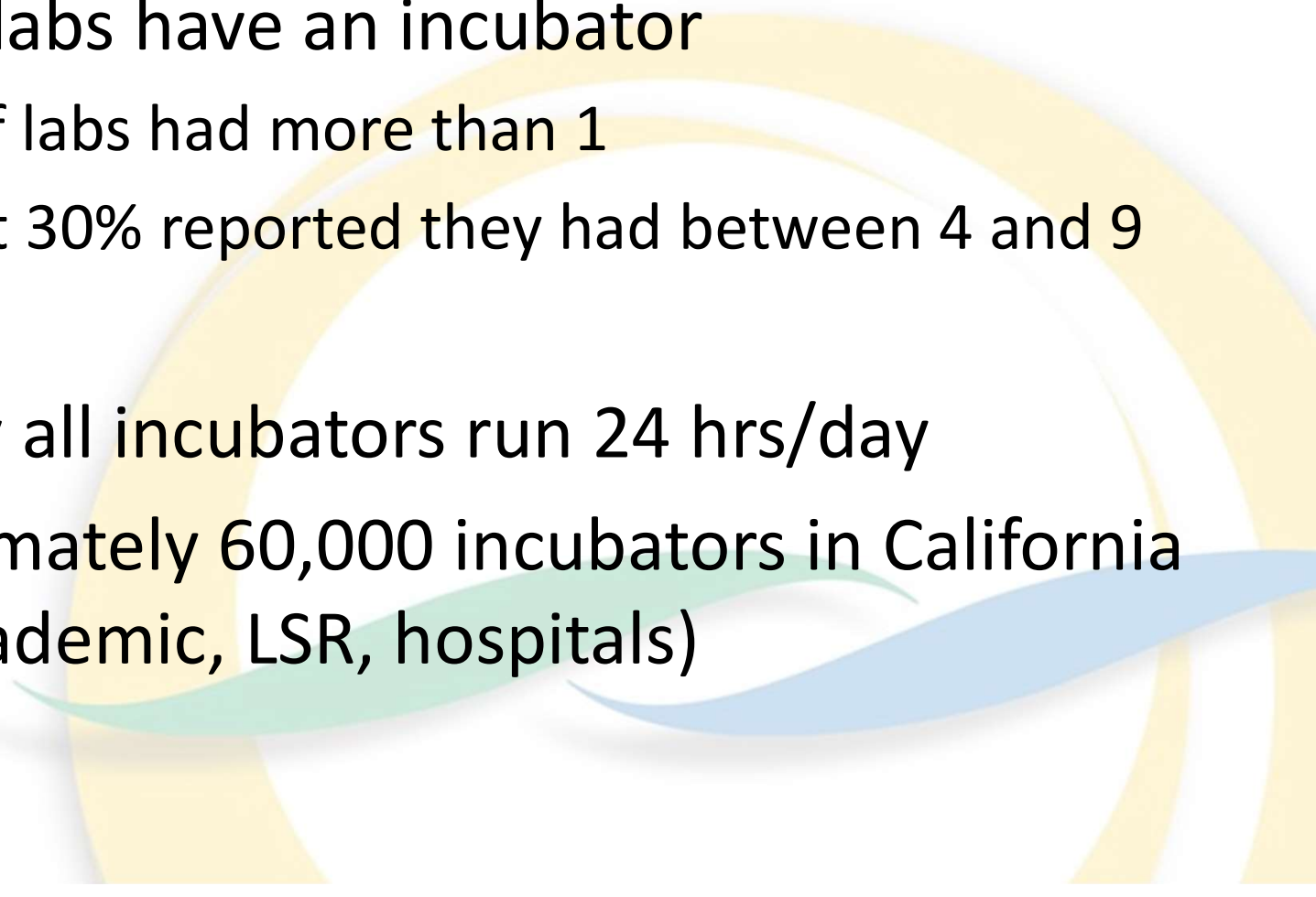
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Incubator Properties

- Temperature ranges between 25°C-60°C
 - Temperature control: $\pm 0.2^{\circ}\text{C}$
 - Temp must be kept constant for consistent fly growth
- Generally range in size from tabletop to full-sized ULT freezer
- Commonly used for cell and tissue cultures, pharmaceutical work, drosophila culture

Incubators are Abundant in Labs

- Estimates of California reported 80% of life science labs have an incubator
 - 60% of labs had more than 1
 - Almost 30% reported they had between 4 and 9
 - Virtually all incubators run 24 hrs/day
 - Approximately 60,000 incubators in California labs (academic, LSR, hospitals)
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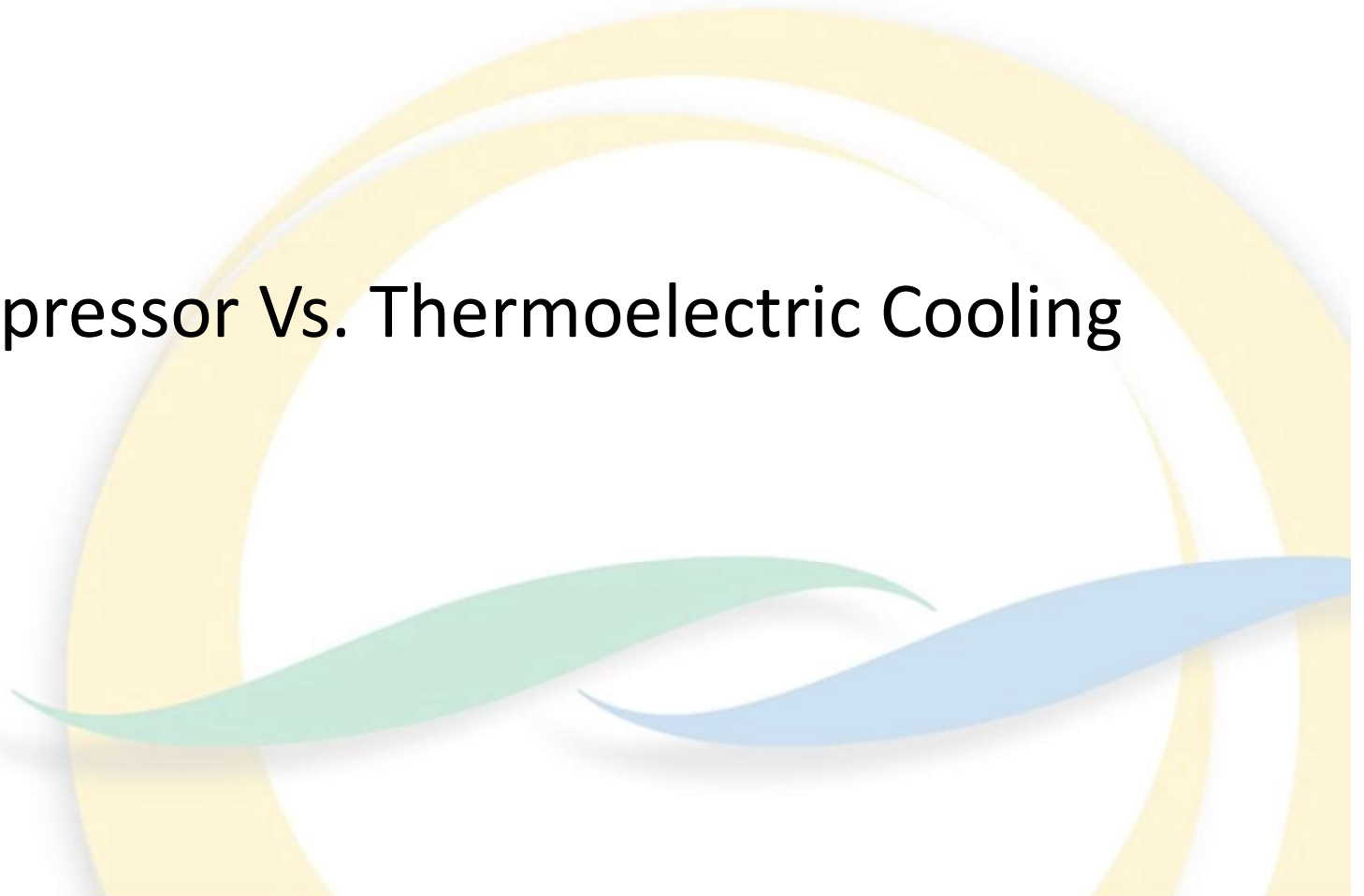
Demand for Efficient Incubators

- Green Labs Survey: What piece of equipment would you like to replace with a more efficient model?
 - 940 labs surveyed
 - Most common answers were freezers, refrigerators, and incubators



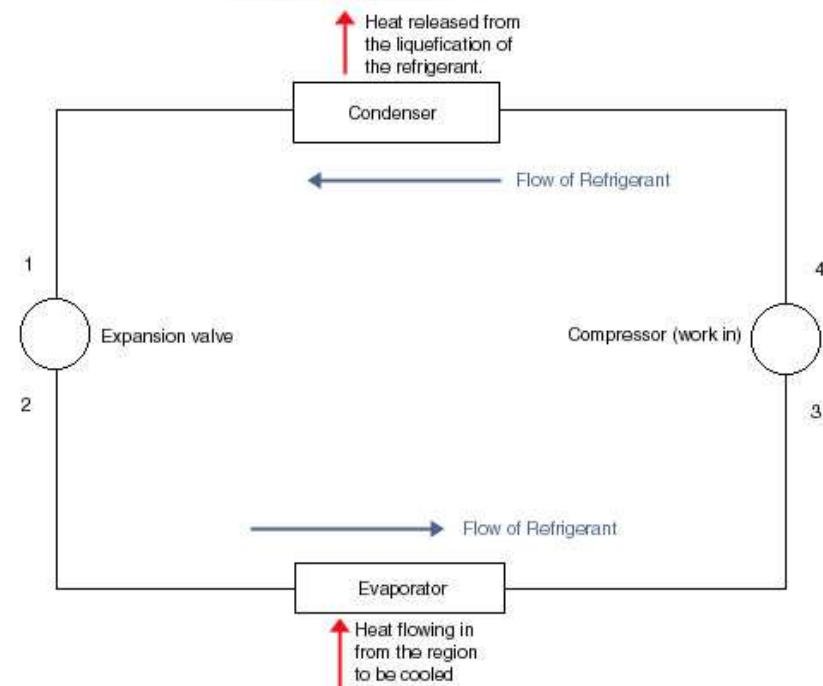
Available Technologies

- Compressor Vs. Thermoelectric Cooling



Compressor-Based Cooling

- Refrigerant flows past area to be cooled, collects heat and gets vaporized
- Compressor raises pressure of refrigerant
- Condenser releases heat, returning refrigerant to liquid form

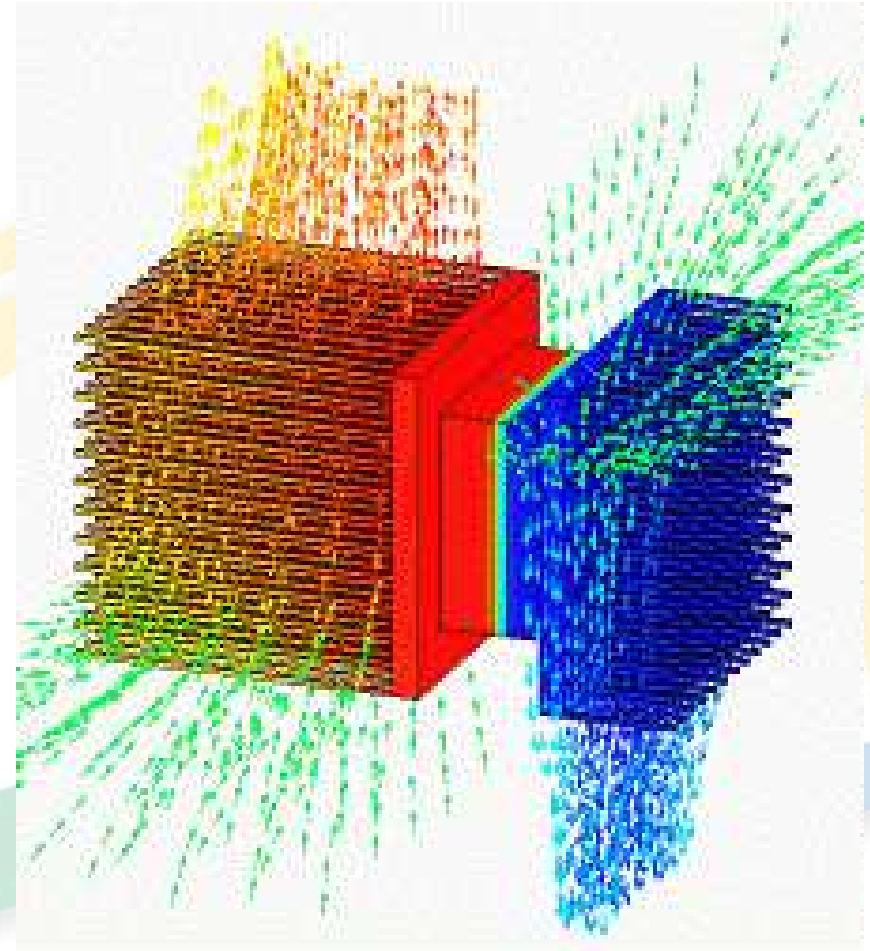


Compressor-Based Cooling

- Current standard method of refrigeration
- “All or nothing” approach with cooling.
 - Compressor is either ON or OFF. No in-between
- Some incubators use constant-refrigeration with heating added in parallel to maintain temperatures, not cycling heating/cooling
- Good for dealing with significant heat loads or cooling to temps below 10°C

Thermoelectric Cooling

- Electric current is applied across a surface, creating a temperature gradient on either side
- Small amounts of current can move small amounts of heat, allowing tight temperature control without “all or nothing” approach



Pros/Cons of Thermoelectric Cooling

- Pros:
 - Few moving parts, so maintenance is likely to be less frequent
 - No vibration, less heat output, and quieter compared to compressor
 - Significantly less energy usage in applications requiring low heat flux
- Cons:
 - Not suitable for temperatures below 10°C

Case Study at UCSB

- Incubators used to breed fruit flies (*Drosophila*)
- 10 Incubators in Lab
 - 6 consume 79.2 kWh/day*
 - 4 consume 41.4 kWh/day*
- Additional costs from increased HVAC load from high heat output



Current Model:
Thermo Scientific 3940
79.2 kWh/day
\$3179/year in plug load cost

*From manufacturer-provided data

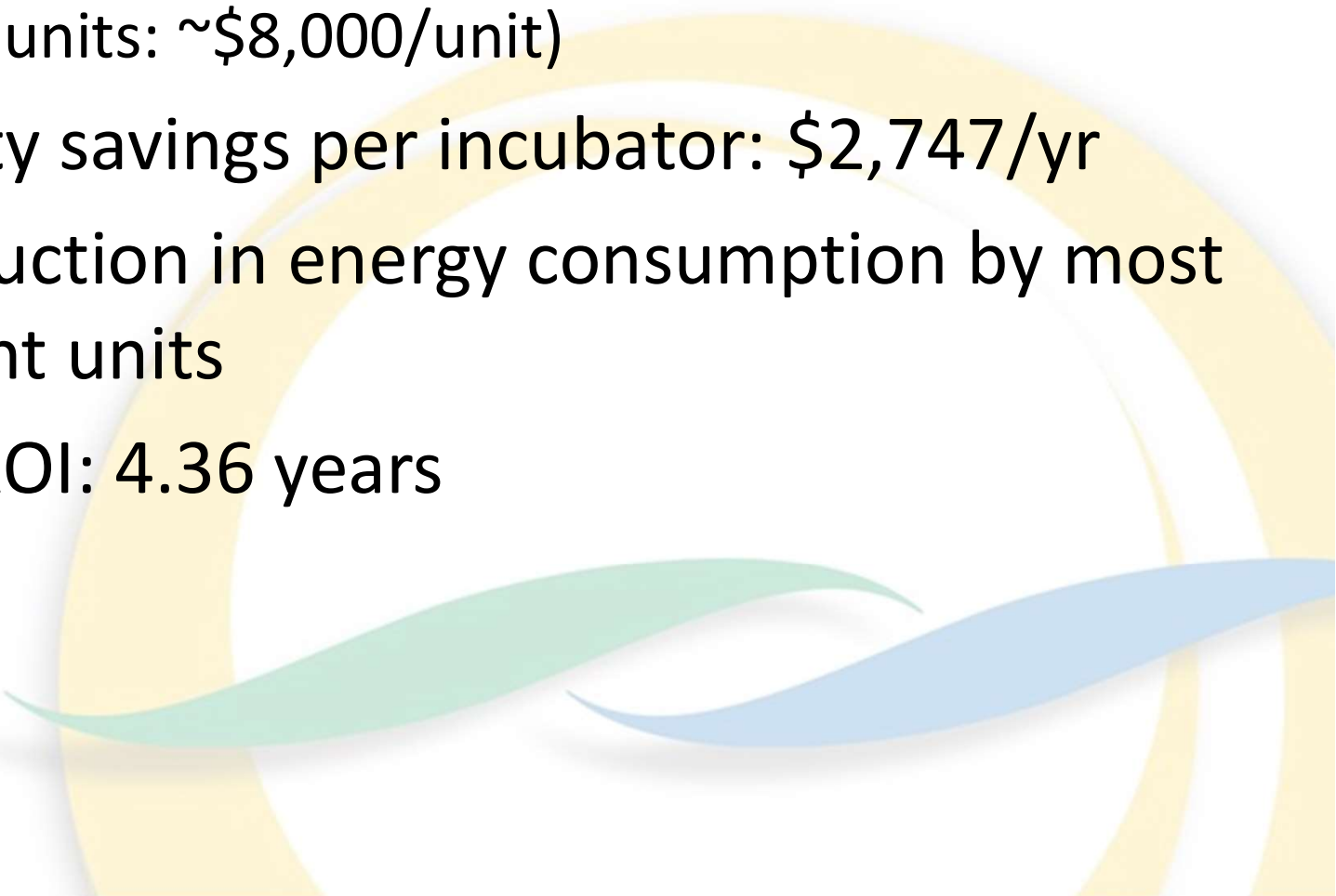
Thermoelectric Replacements

- Replacement Units:
 - Meet all specifications by the lab
 - Cycling thermoelectric cooling system
 - No heater/compressor, only moving parts are heat sink fans
- Per Incubator Replaced:
 - 24,980 kWh/year saved
 - \$2,747/year in plug load savings
 - Additional savings will be found in reduced HVAC load

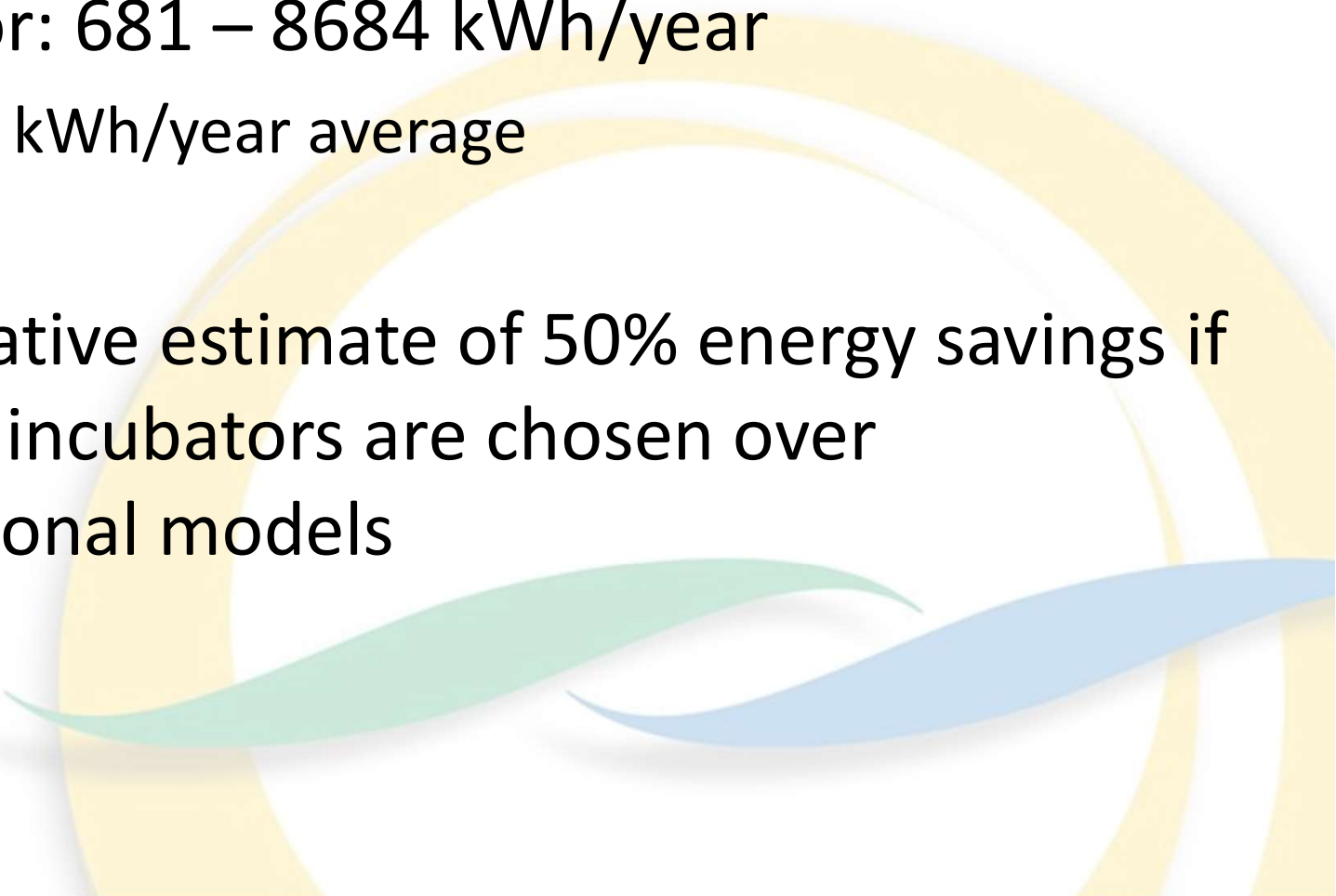


Replacement Model:
Darwin Chamber IN034
10.76 kWh/day
\$432/yr in plug load cost

Project Analysis

- Replacement incubators: ~\$12,000/unit
(Original units: ~\$8,000/unit)
 - Electricity savings per incubator: \$2,747/yr
 - 86% reduction in energy consumption by most inefficient units
 - Simple ROI: 4.36 years
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Potential Statewide Energy Savings

- Estimated energy consumption per year per incubator: 681 – 8684 kWh/year
 - 4682.5 kWh/year average
 - Conservative estimate of 50% energy savings if efficient incubators are chosen over conventional models
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Potential Statewide Energy Savings

- (80,000 incubators * 4682.5 kWh/yr average)
0.50 energy savings
- 187,300,000 kWh/year estimated potential savings if efficient incubators replaced standard models in CA
- Equivalent to 61,000 metric tons CO₂ yearly

Implications for Future Purchasing

- In situations with low cooling requirements, thermoelectric cooling is an efficient alternative to compressor technology
 - Short ROI makes replacement of existing units a good opportunity for immediate savings
 - Due to higher cost of thermoelectric incubators, incentive funds could be well used to help labs purchase efficient units
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