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*The Link between  
Mold and Energy Projects  
-and-  
A Comparison of the Latest  
Dehumidification Technologies*

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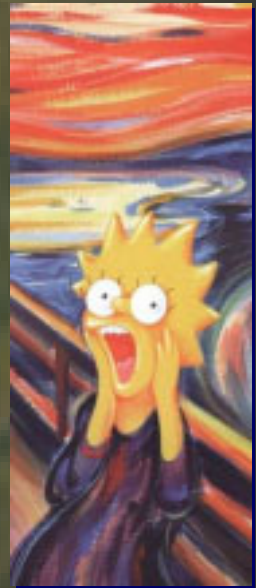
[www.advantekinc.com](http://www.advantekinc.com)

**AdvanTek**

# *The Frenzy Over Mold*

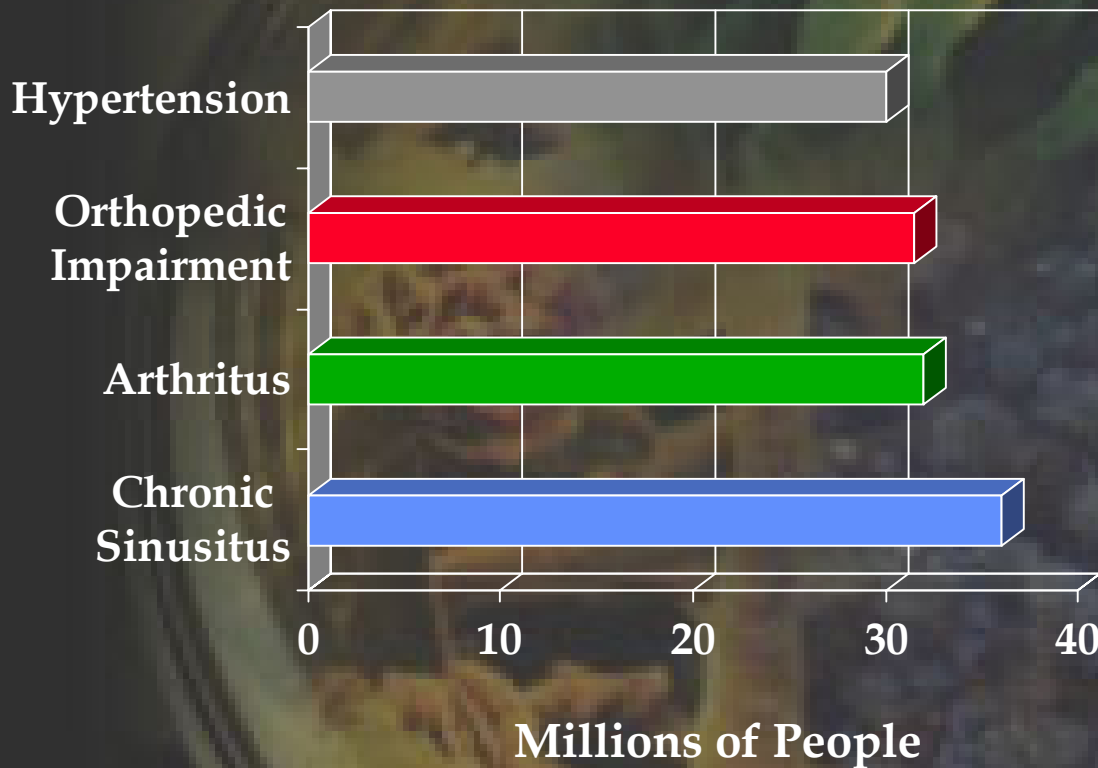
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- ❑ Settlements for mold claims in 2001 topped \$85 billion
- ❑ Toxic mold litigation cases have increased 10 fold over the past year
- ❑ An estimated 10,000 mold suits are already pending
- ❑ Large verdicts against building owners, property managers, contractors, architects, etc.



# Mold and IEQ

- **Chronic Sinusitis affects millions**



➤ Most sufferers probably have **allergic fungal sinusitis**.

*Mayo Clinic '99*

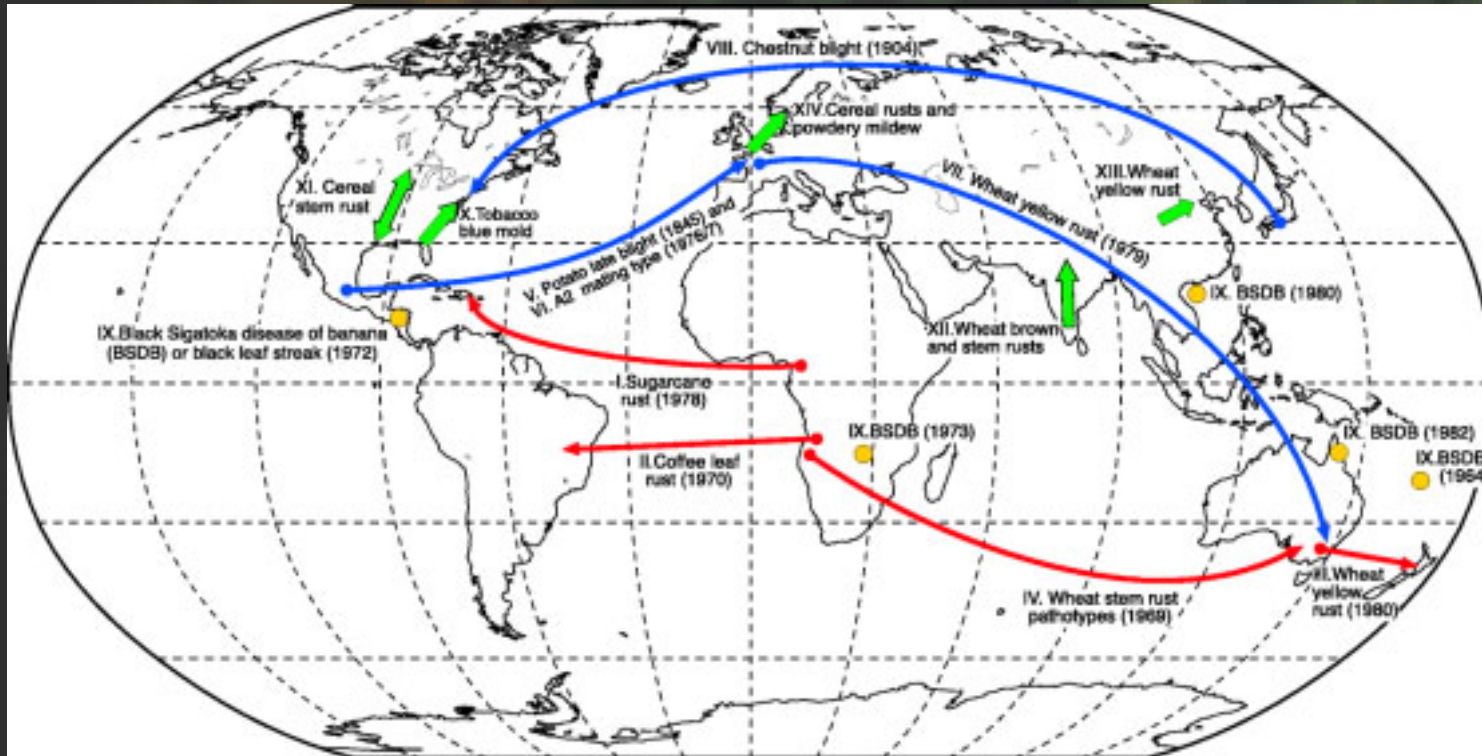
➤ Role of fungal exposure yet unclear, studies in progress

➤ **This** could become a major moldy building health issue

Source: Institute for Health Statistics, 1995

# Mold Spores

- decompose plant and animal structural materials
- help (probably all) plants absorb water and minerals
- **Mold easily cross continents and oceans**



**You  
cannot  
escape  
THEM**

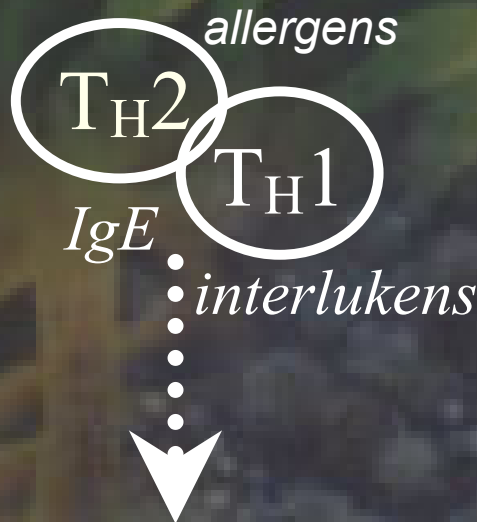
Source: Science, 297, 26 July 2002

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January 21, 2003 ASHRAE Cocoa Beach, Florida

# *The Hygiene Hypothesis: Lack of 'normal' human exposures shifts the immune system to allergic responses*



Vaccines, hygiene, & antibiotics,  
little  $T_H1$  stimulus,  
increased  $T_H2$



Helminth parasites,  
Strong  $T_H2$  responses

**Low exposure to pathogens:**  
*weak regulatory network*



**Inflammatory  
responses**



**Allergic responses:**  
**Asthma, rhinoconjunctivitis**

**High exposure to pathogens:**  
*strong regulatory network*



**Positive skin test for allergens:**  
*but little allergic disease*

# *Expect continued increase in mold-related health effects*

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- **worsening existing asthma symptoms<sup>1</sup>**
- **causing chronic allergic fungal sinusitis<sup>2</sup>**
- **aggravating or causing allergic rhinitis<sup>1</sup>**
- **reducing productivity - lost time, medical costs**

***no proven medical cures in sight***

Sources: 1. *Clearing the Air: Asthma and Indoor Air Exposures*, National Academy of Science, Institute of Medicine  
2. J.U.Ponikau, "The Diagnosis and Incidence of Allergic Fungal Sinusitis" Mayo Clin. Proc. 1999;**74**:877-884

# *Moldy Ceiling Tiles*

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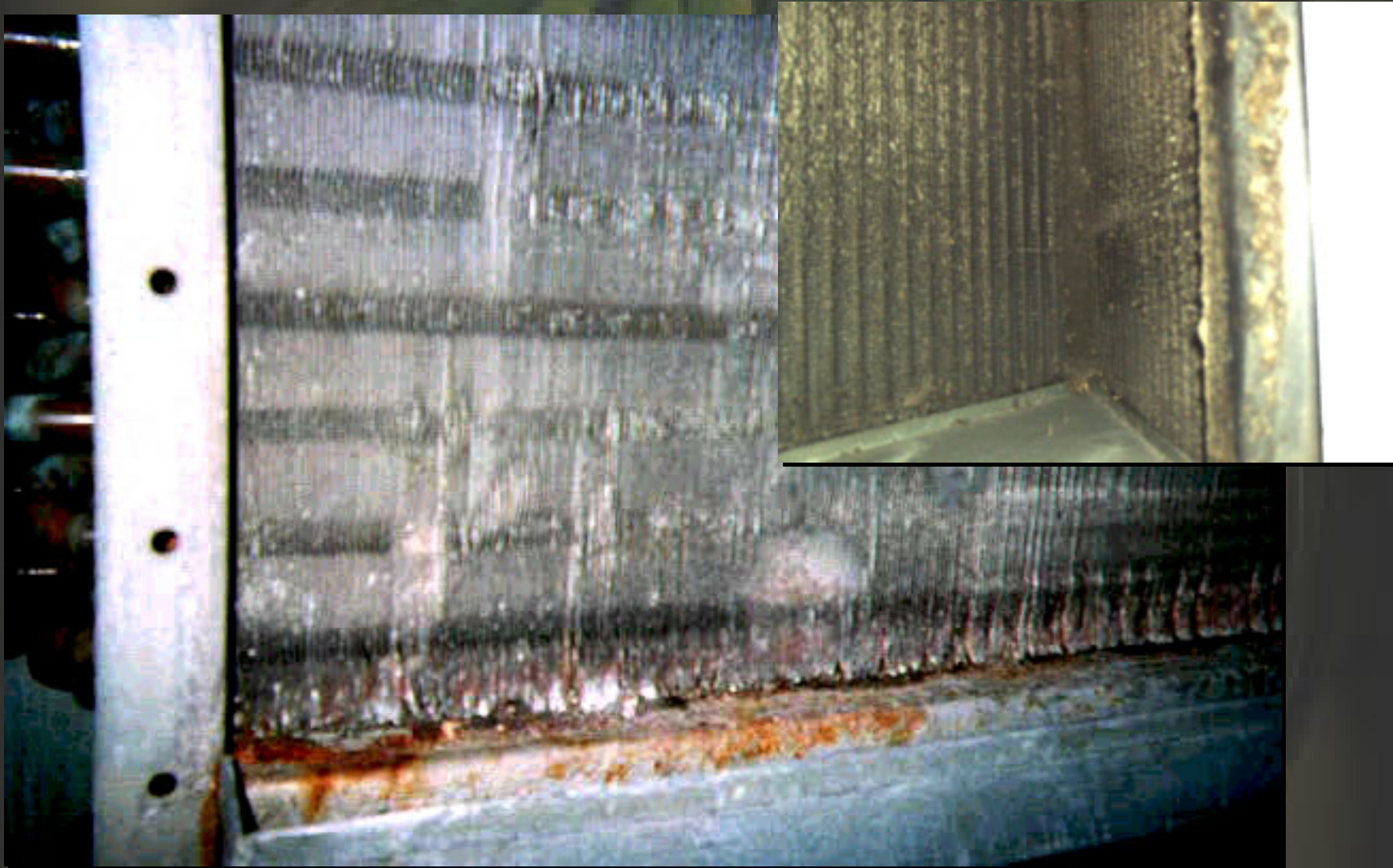


# *Moldy Ceiling Return Air Plenum*

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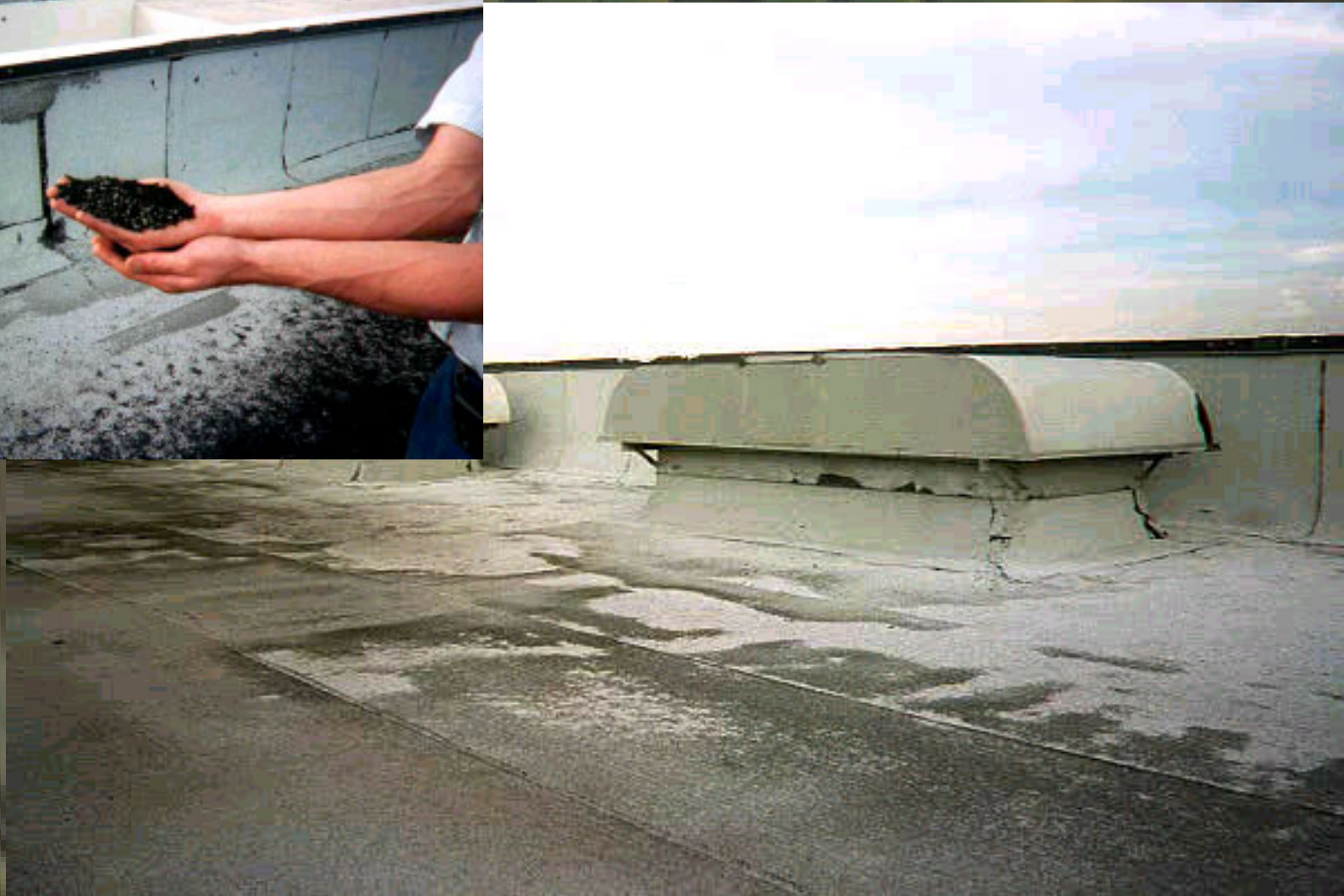
# *Moldy Cooling Coils*



# *Moldy Drain Pans*



# *Mold on Roof Near Fresh Air Intakes*



# *Cooling Tower Near Intakes*



# *Tower Water Contaminated*

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# *Moldy Walls*



# *Mold everywhere*



# *The Cure:*

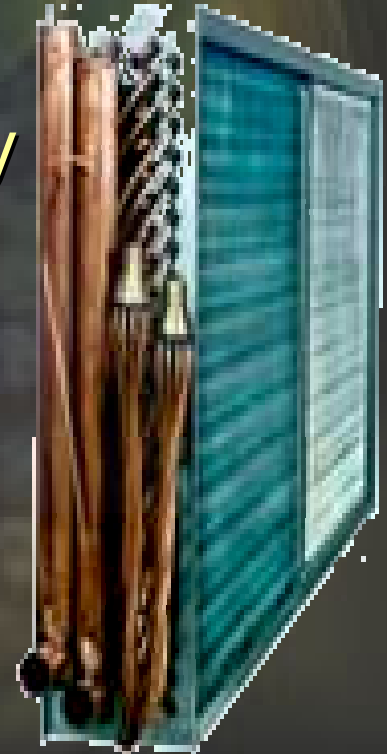


- **Mold is a part of Life on Earth, It Is Not Going Away**
  - **Mold Causes Serious Health Effects**
- **Any Active Mold Growth Indoors is Unacceptable**
- **Excessive Humidity Causes Active Mold Growth**

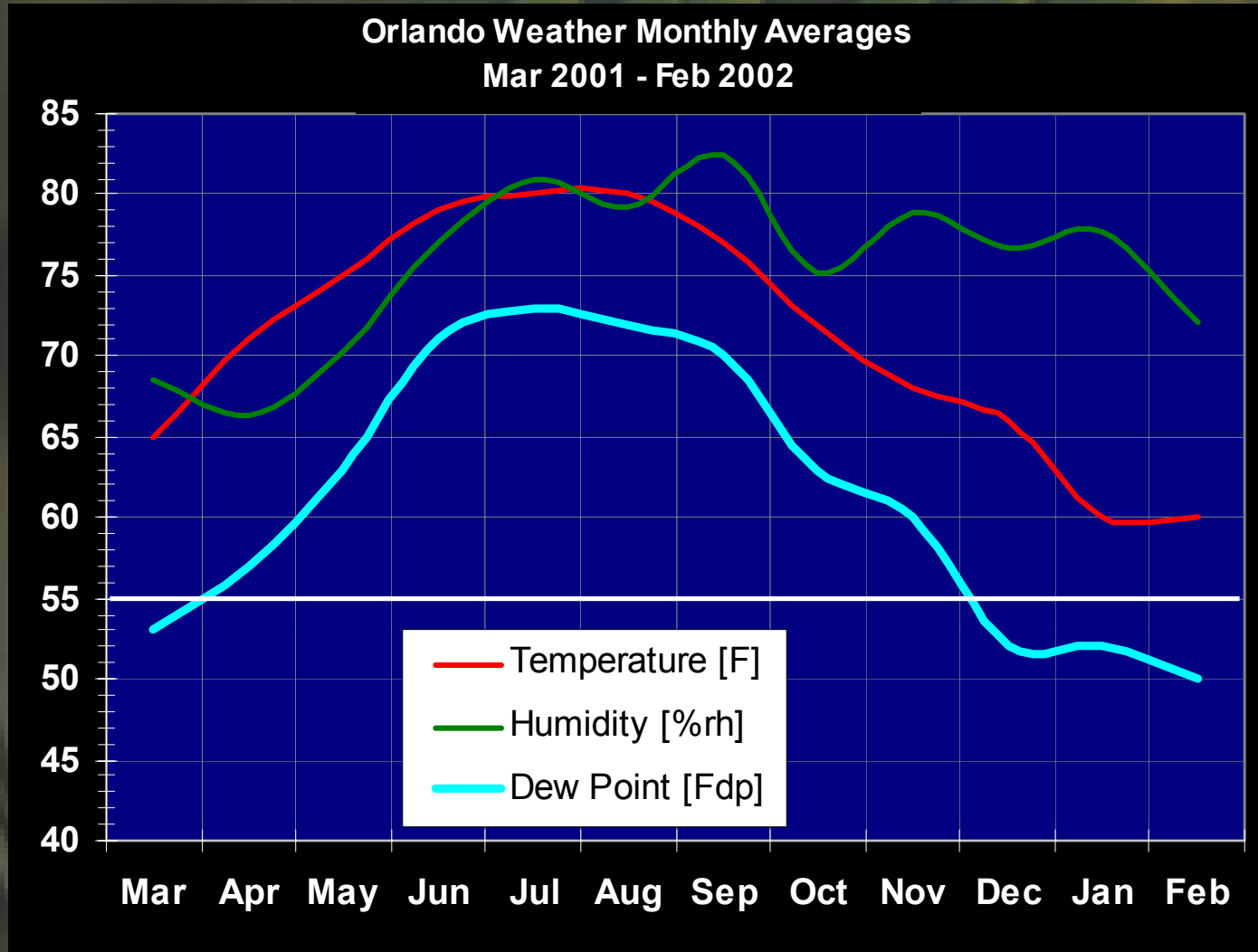
***Control the Moisture, Control the Mold***

# Controlling Mold Growth

- ❑ Contaminated HVAC systems are incubation sites for biologics and readily distribute spores and toxins
- ❑ *Mold and other biologics need high moisture, moderate temperature, and food*
- ❑ Growth of mold can be minimized by controlling moisture and humidity
  - **LINKS MOLD TO ENERGY USE**



# Annual Weather Profile



# Mold and Energy Efficiency

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- ❑ **Some energy efficiency measures can result in Mold problems**
  - VAV with fixed system outdoor air flow
  - reduction in outdoor air flow rates
  - extreme temperature setbacks
- ❑ **Some Mold prevention measures can increase energy costs**
  - raising OA flow and/or exhaust flow
  - installing HEPA filtration
  - controlling high humidity with reheat

# Mold and Worker Efficiency

## Employee Satisfaction

## Customer Satisfaction

→ Teamwork → Less Error → Better Cycle → Quality of Service →

Absenteeism

Health Costs

Quicker Recovery

Safety

Turnover Rate

Better O&M

Output per person

Fewer Pay Demands

Recruitment

**Effectiveness**

**Performance**

**Productivity**

**Financial Performance**

Sales

Profitability

Shareholder Value

Sustainability

Looks Better

Better Visibility

Fewer returns

Improved Comfort

No Allergy Symptoms

Better Security

→ Repeat Business

→ Loyalty

# Mold and Productivity

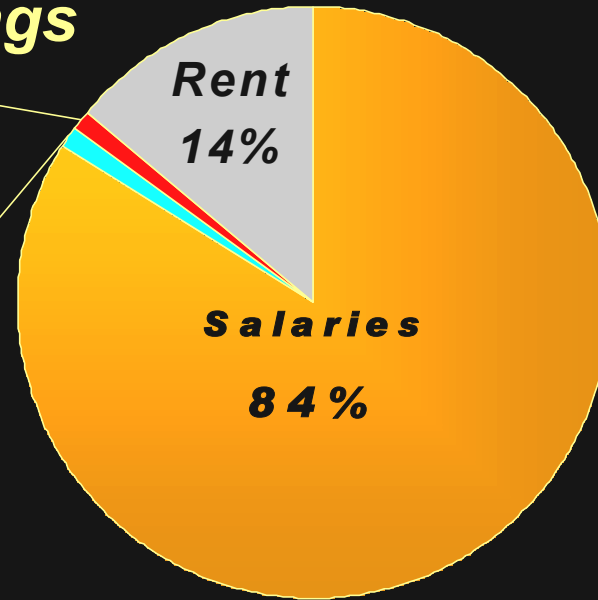
## Annual Square Foot Costs of Commercial Buildings

Maintenance  
1%

Energy  
1%

Rent  
14%

Salaries  
84%



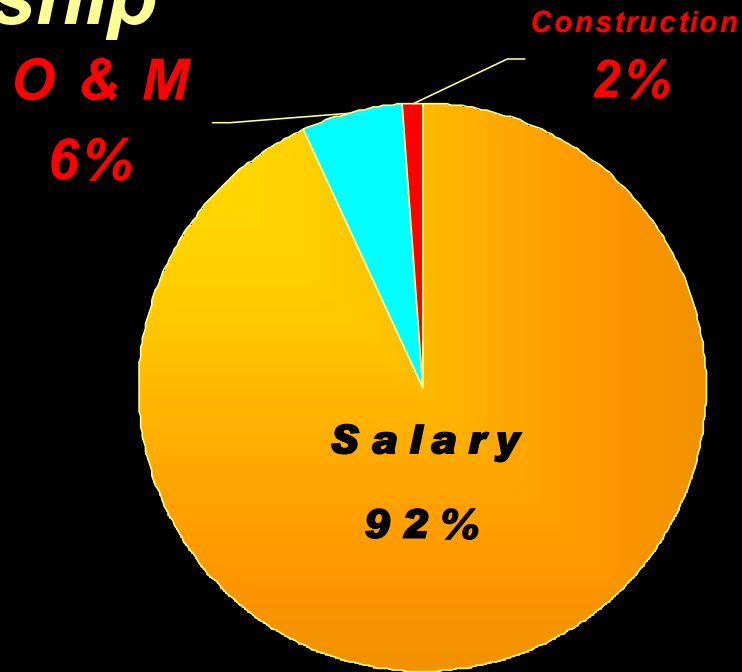
*A 1% annual productivity gain  
almost equals annual energy costs  
1 hour salary ≈ annual office lighting cost*

$1.2 \text{ W / sq. ft.} \times 100 \text{ sq. ft.} \times 3500 \text{ hrs / yr} \times \$ .05 / \text{kWhr} = \$21$  ~~or~~  $1000 \text{ W / kW hr} = \$25/\text{hr}$

© David P. Harlos, 2002

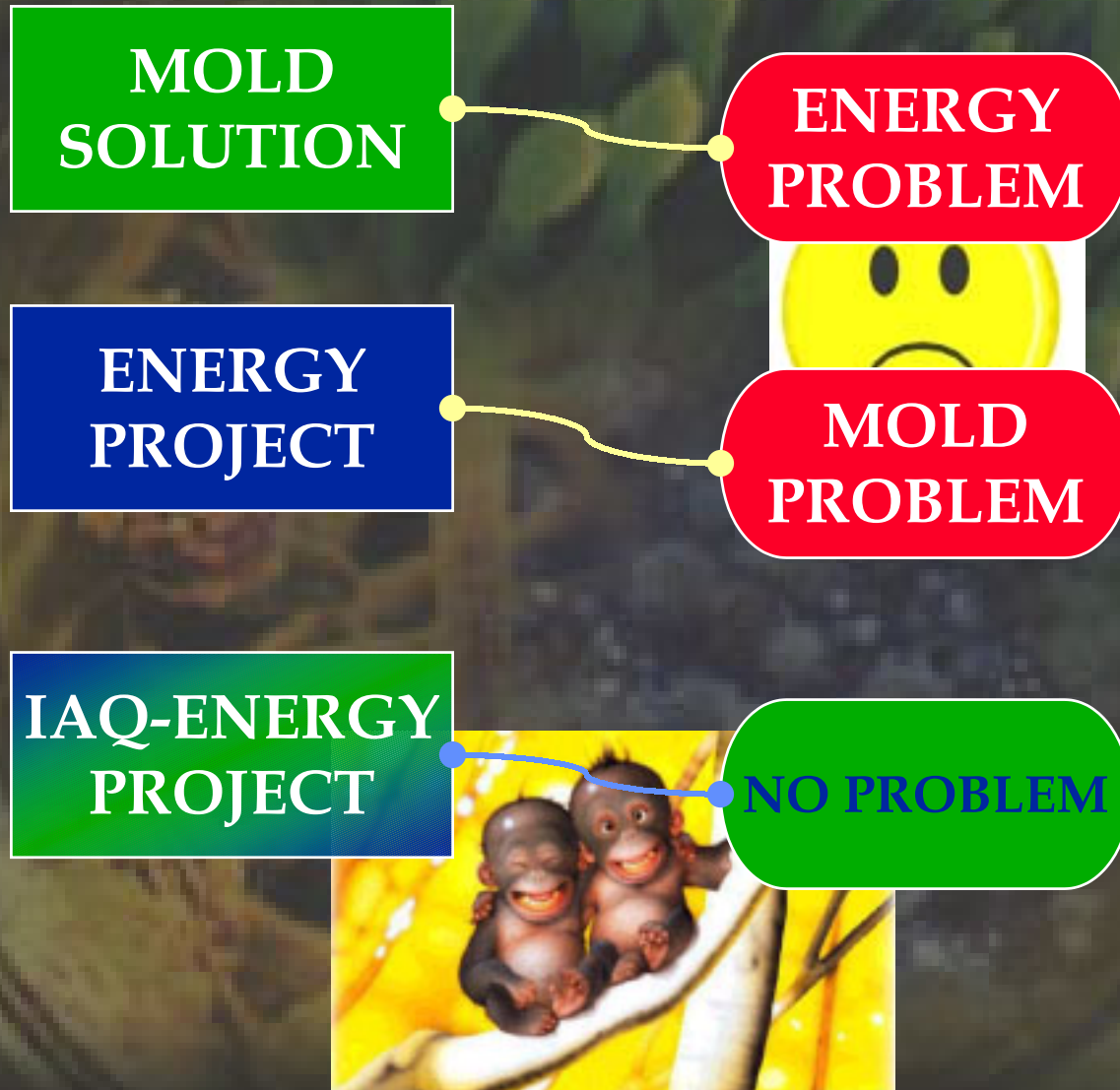
# *Mold and Productivity*

## **30-Year *Costs* of Commercial Building Ownership**



*A 1% productivity gain EXCEEDS energy, maintenance & construction costs.*

# 3 Linkage Types

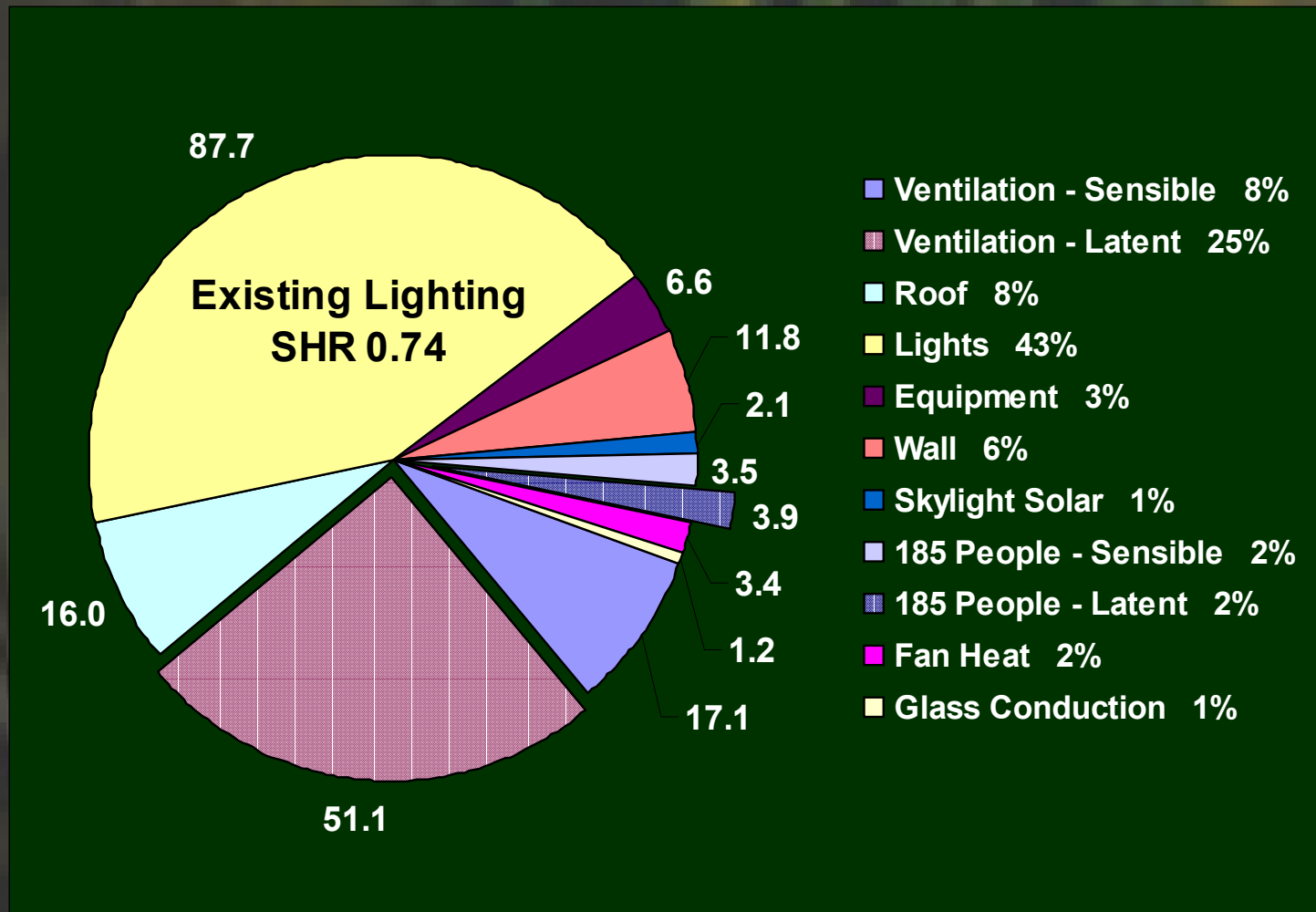


- ❑ Active dehumidification using heat
  - Also, portable dehumidifiers
- ❑ Pressurization without air-tightening
- ❑ Lowering chilled water setpoint
- ❑ Changes in OA - Exhaust CFM
- ❑ Activated carbon / HEPA filtration
- ❑ Low-efficiency HVAC equipment
  - **Lower Humidity, Higher Energy Costs**

- ❑ Reduction of fresh air CFM
- ❑ Certain high-efficiency HVAC units
  - Row-split or intertwined evaporator coil
  - High airflow and evaporator temperature
- ❑ Roof or ceiling insulation
- ❑ Reducing solar gain from windows
- ❑ High-efficiency lighting
  - **Lower Energy Costs, Higher Humidity**

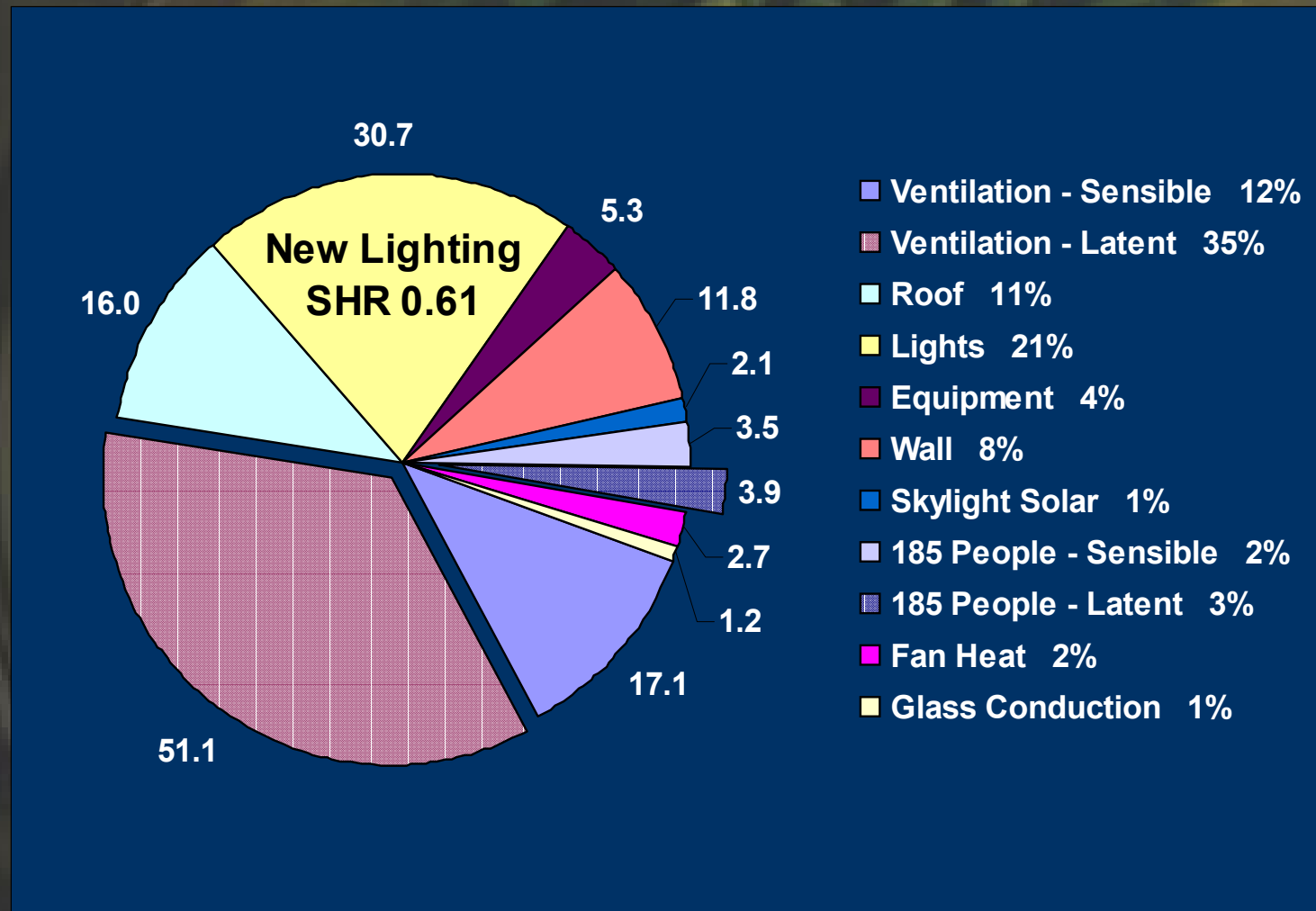
# ... *High Efficiency Lighting?*

- Heat from lighting helps keep humidity down



# *How lighting is related to Mold*

- Energy efficient lighting shifts HVAC load



# *Examples:*

- ❑ Re- or retro-commissioning
- ❑ Energy-efficient dehumidification
- ❑ Air-tighten building windows, doors, ...
- ❑ Balance fresh air and exhaust air
- ❑ Optimize HVAC settings and controls
- ❑ *Select* high-efficiency HVAC upgrades
  - **Lower Humidity**
  - **Lower Energy Costs**

# *Energy Efficient IAQ Measures*

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## ❑ **Coil Cleaning**

- Eliminate or control incubation sites

## ❑ **Ventilation**

- Pressurize the space with filtered and dehumidified air to keep moisture out

## ❑ **Air Cleaning**

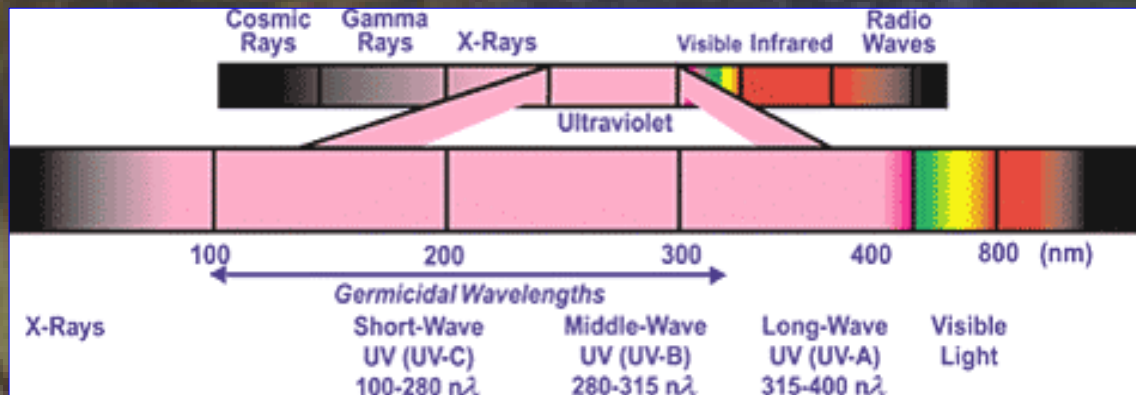
- Removal of airborne spores

## ❑ **Dehumidification**

- Active control *without* reheat

# Coil Cleaning

- ❑ Ultraviolet Light: Short-wavelength (UVC)
- ❑ Deactivates the DNA of bacteria, viruses and molds and thus destroys their ability to multiply
- ❑ Maintains cooling coil condition and energy efficiency while killing mold and bacteria
  - ❑ **Key is Dosage = Intensity x Duration**



# Ventilation

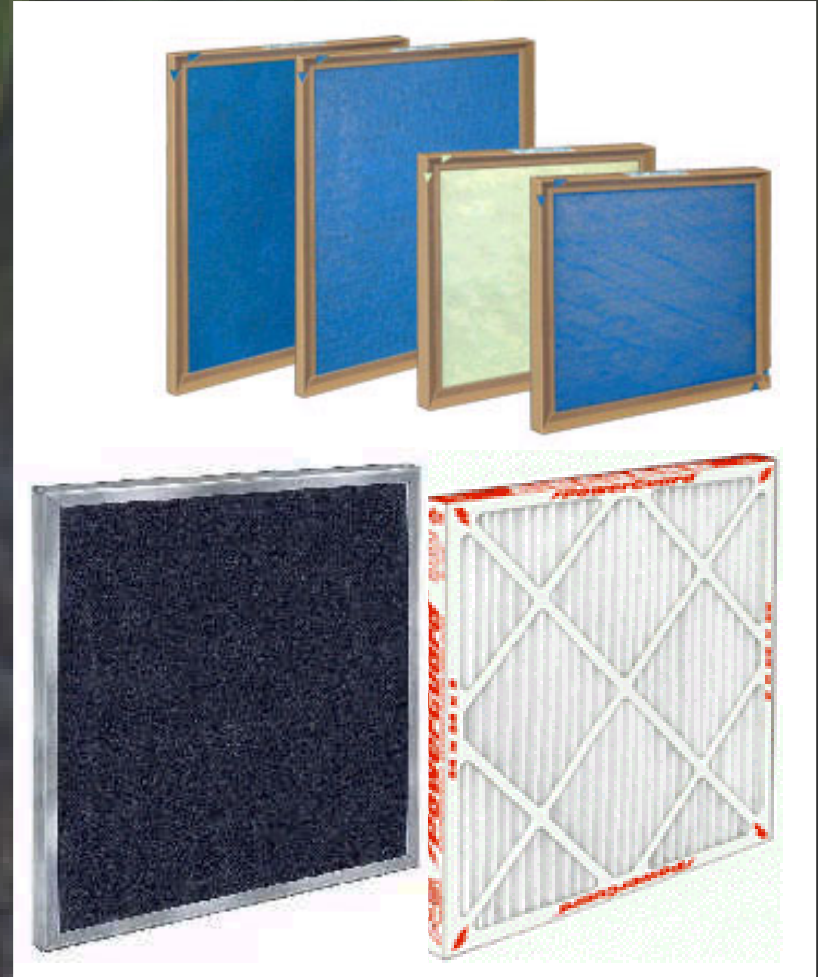
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- ❑ Exhaust outflow less than OA inflow
  - Keeps outdoor contaminants out
- ❑ Minimum 0.03 to 0.05 in.wg (7 to 12 Pa)
  - Differential cfm depends on airtightness
  - Predict zone pressures using software
- ❑ Define airflow between building zones
- ❑ Test, adjust & balance upon installation
- ❑ Control with airflow tracking or dP sensor

# Air Cleaning

## ■ 52.2 Efficiency Rating

- Pollen, Dust Mites
  - MERV-4
- Mold, Spores
  - MERV-8
- Some Bacteria
  - MERV-12
- Smoke, Toner
  - MERV-16
- Viruses - HEPA



# Dehumidification

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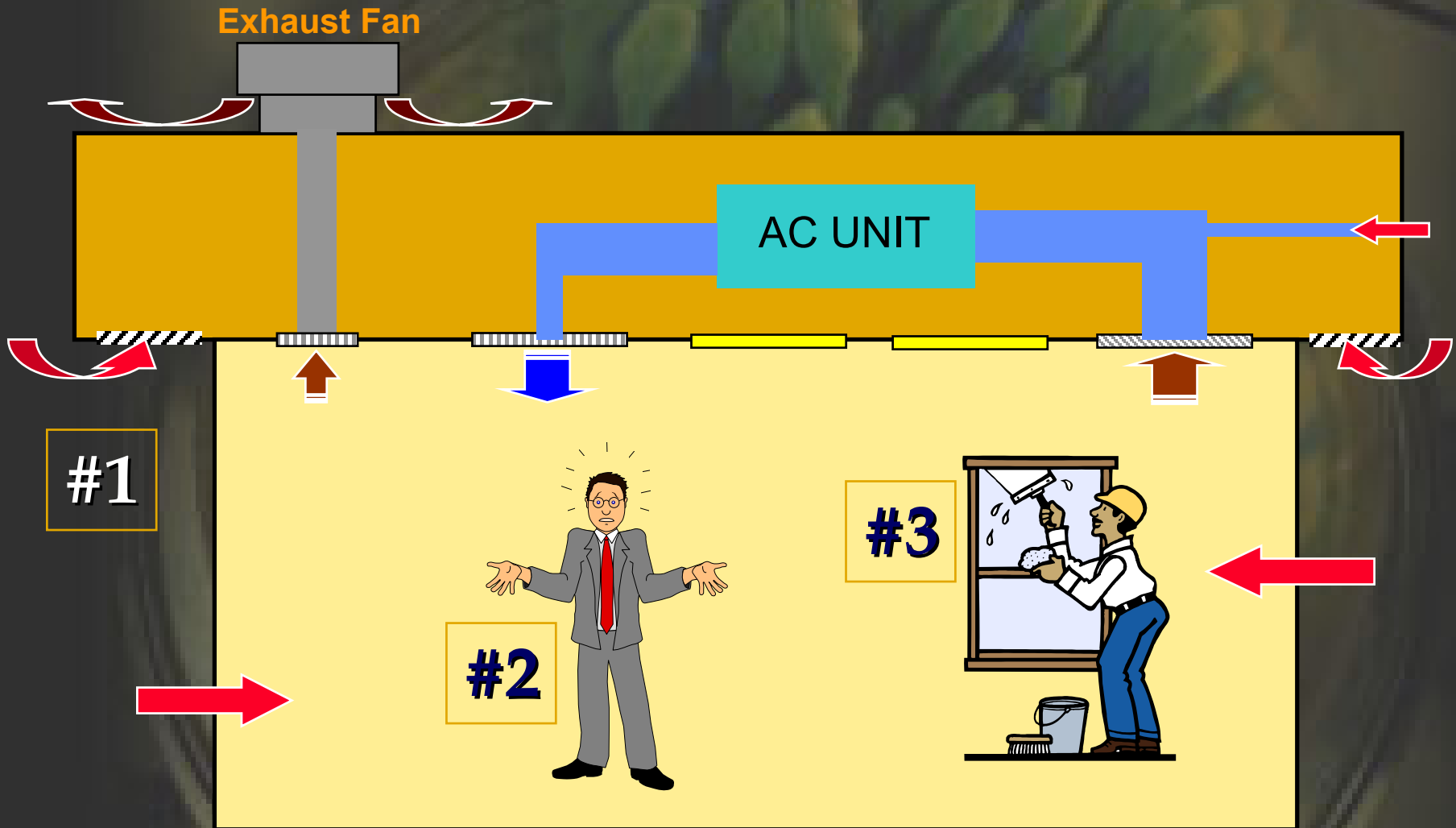
## ❑ REHEAT

- Electric Reheat
- Hot-gas Reheat (*Humiditrol™*)
- Subcool Reheat (*Moisture Miser™*)

## ❑ OPTIMAL CONTROL (all are patented)

- Subcool-Bypass (*Comfort Stat™*)
- Controllable Heatpipes
- Crossflow Moisture Exchange

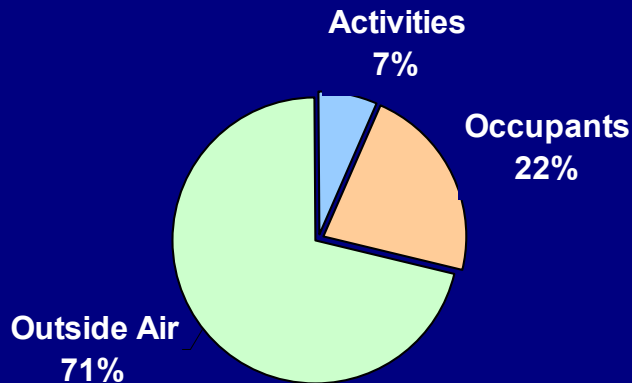
# Sources of Humidity



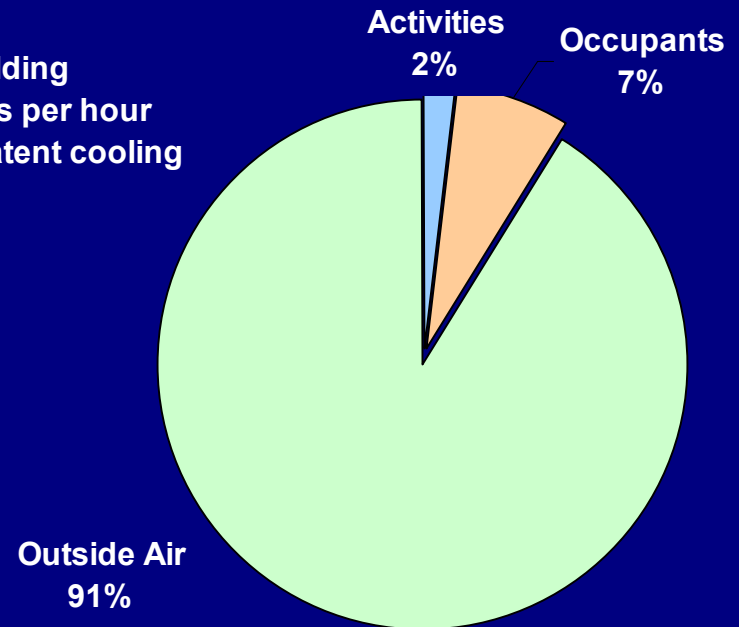
# Sources of Humidity

- ❑ Outside air is by far the main source

**Example**  
2000 cfm by code  
12 gallons per hour  
9 tons latent cooling



**Example**  
leaky building  
40 gallons per hour  
30 tons latent cooling



Example for daily average 88F 60%rh - 100 occupants - 50,000 square feet

# *Equipment Comparison*

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- ❑ Standard Rooftop Units
  - Electric reheat
  - Optimized airflow and control
  - Dehumidifier heatpipe coil
- ❑ Premium Package Units
  - *Lennox “Humiditrol™”*
  - *Carrier “Moisture Miser™”*
- ❑ Cutting-edge technologies



# Seen this before?

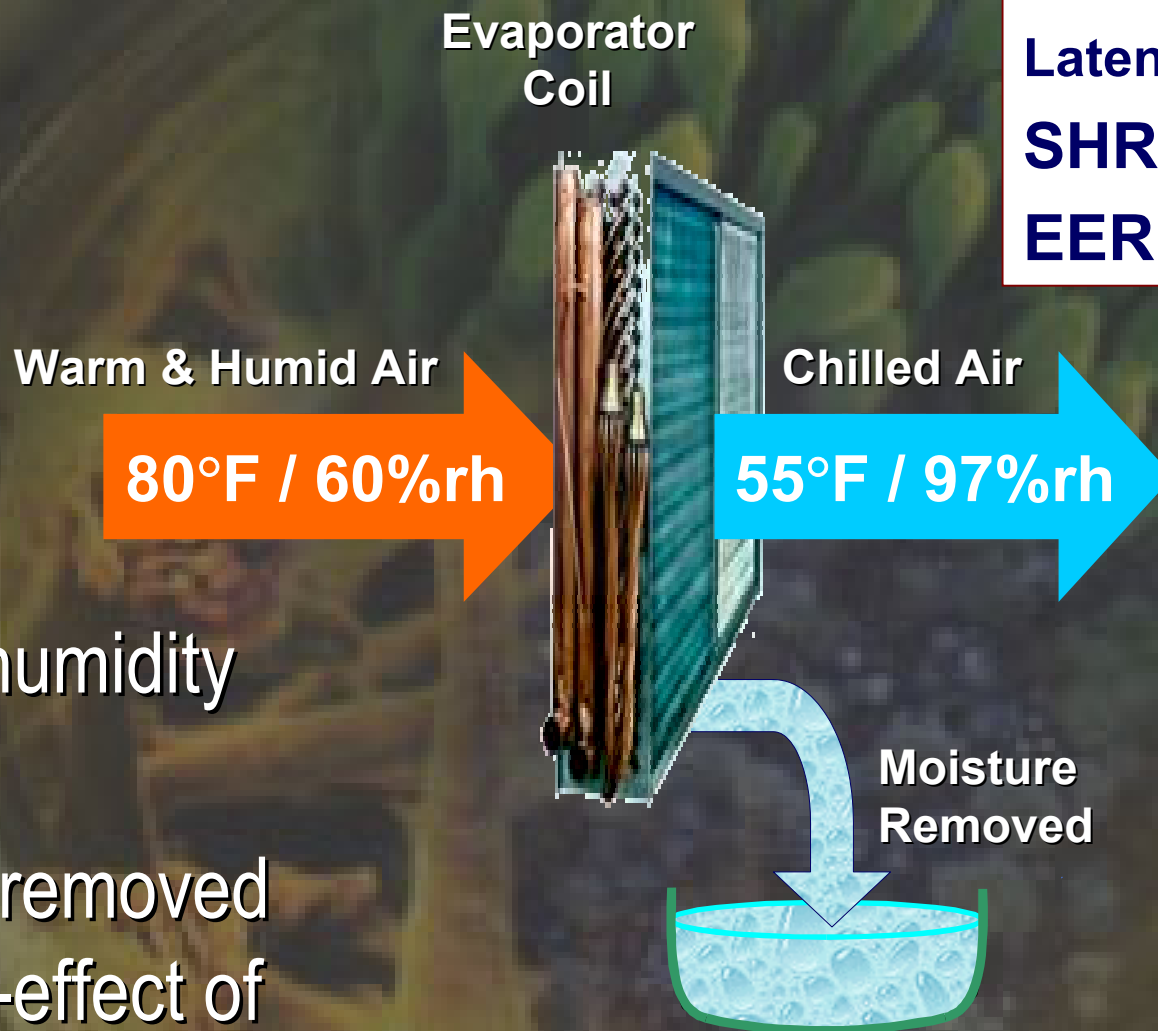
## REPORT CARD

**Capacity** 35MBH/kcfm

**Latent** 10

**SHR** 0.71

**EER** 10.0



Passive humidity  
control

Moisture removed  
as a side-effect of  
cooling

# REHEAT: Electric

Evaporator  
Coil

ELECTRIC  
HEAT  
Coil

Capacity 26

Latent 10

SHR 0.61

EER 4.1

Warm & Humid Air

78°F / 60%rh

Chilled Air

55°F / 97%rh

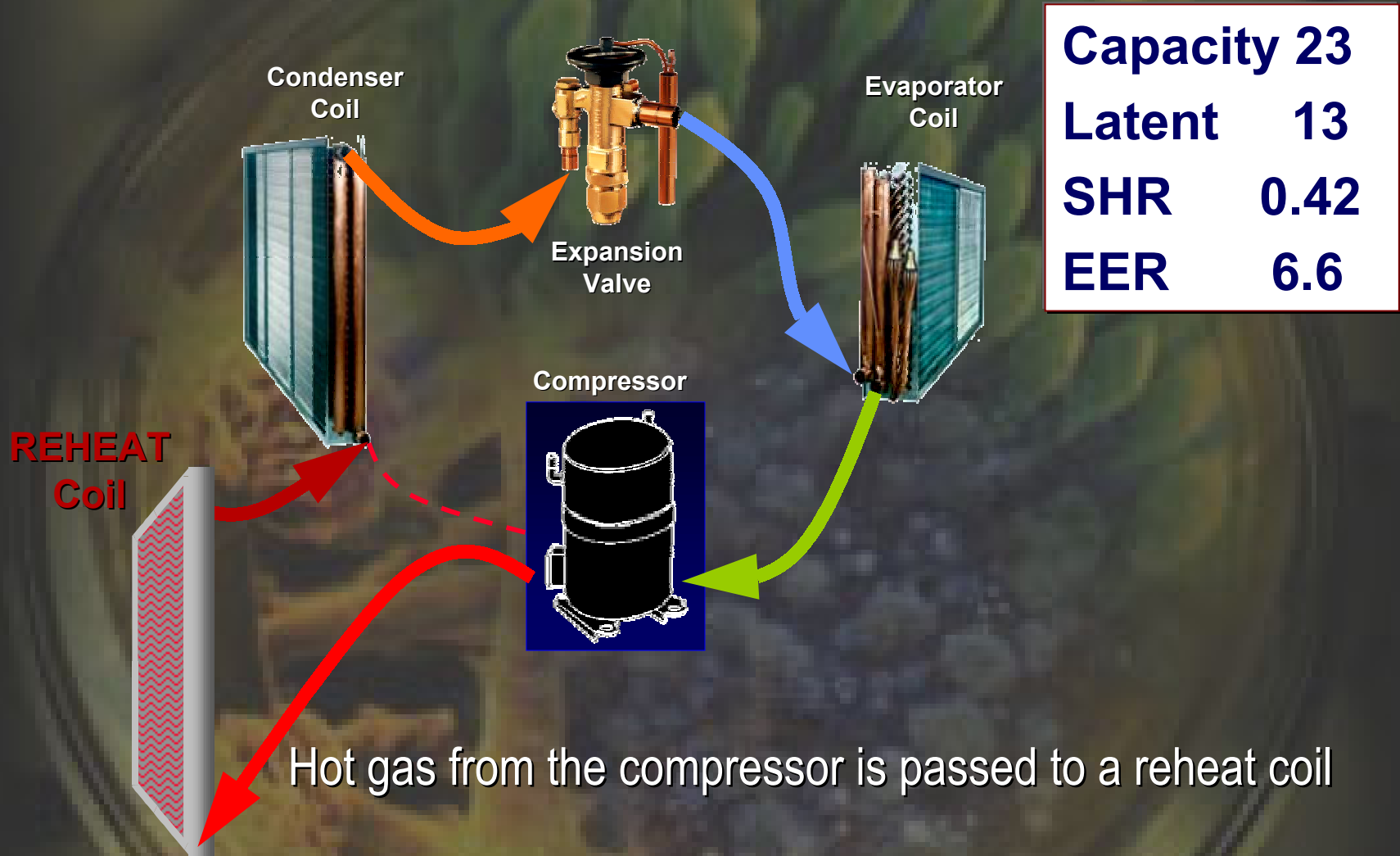
Supply  
Air

64°F / 70%rh

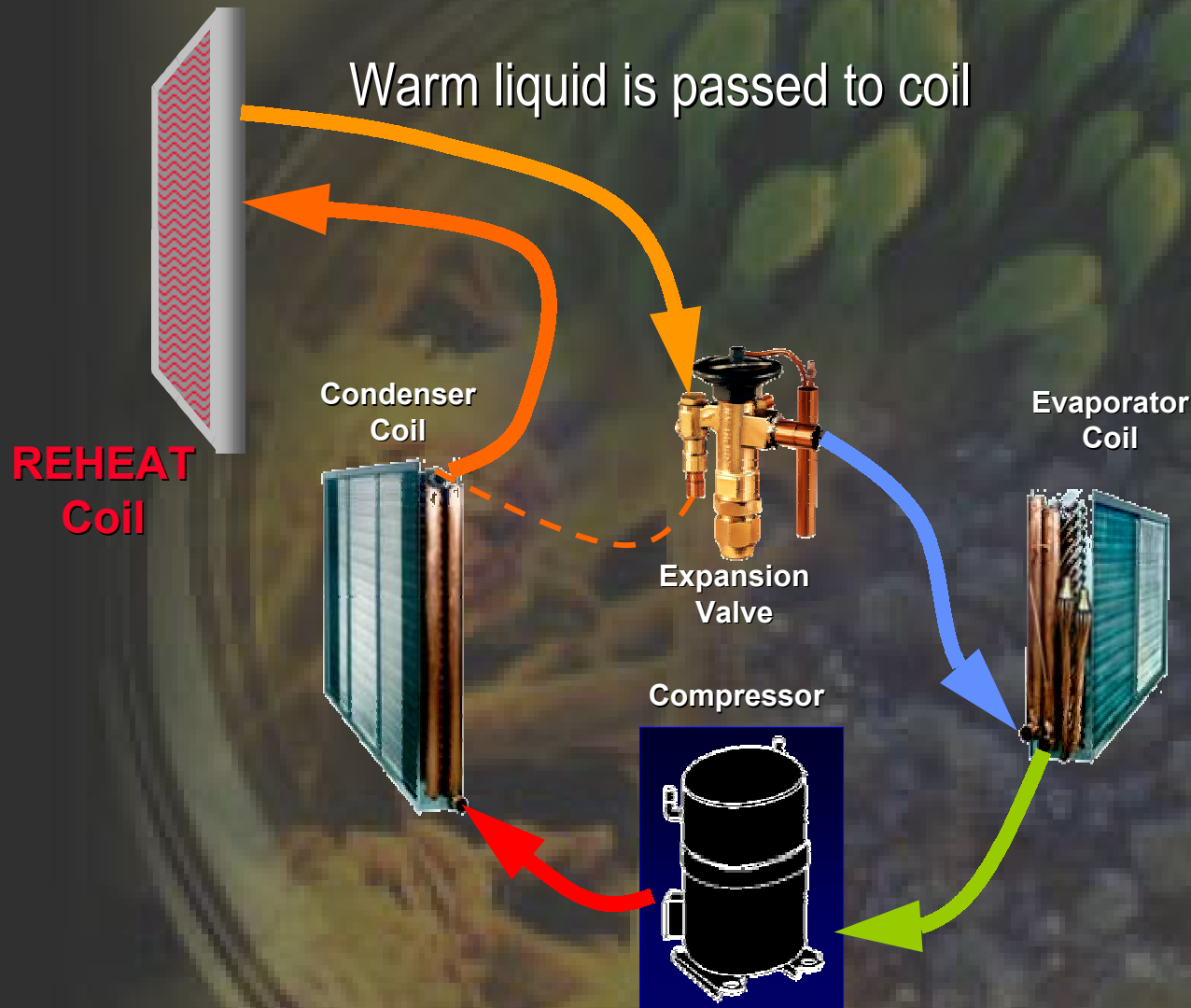
Moisture  
Removed

2.8 kW per kcfm

# REHEAT: Hot-gas (Humiditrol™)



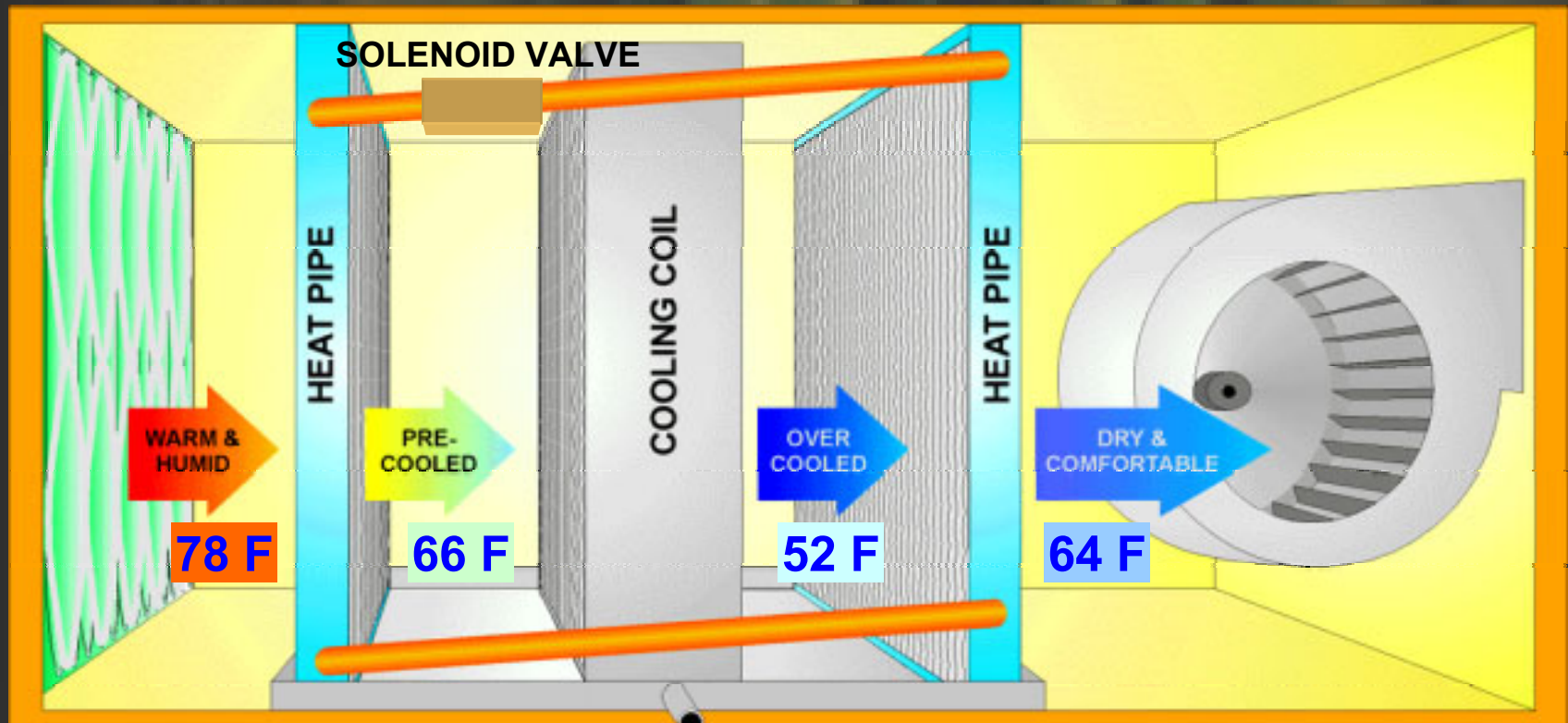
# REHEAT: Subcool (Moisture Miser™)



Capacity	29
Latent	14
SHR	0.52
EER	8.2

# Controllable Heat Pipes

Capacity	34
Latent	17
SHR	0.50
EER	9.7



*Precool*

*Reheat*

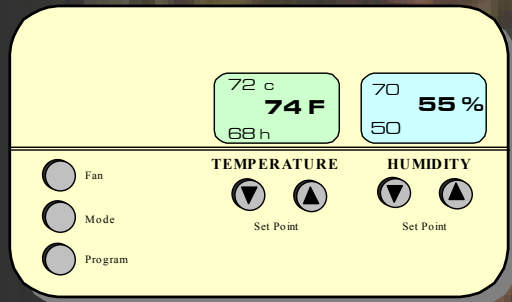
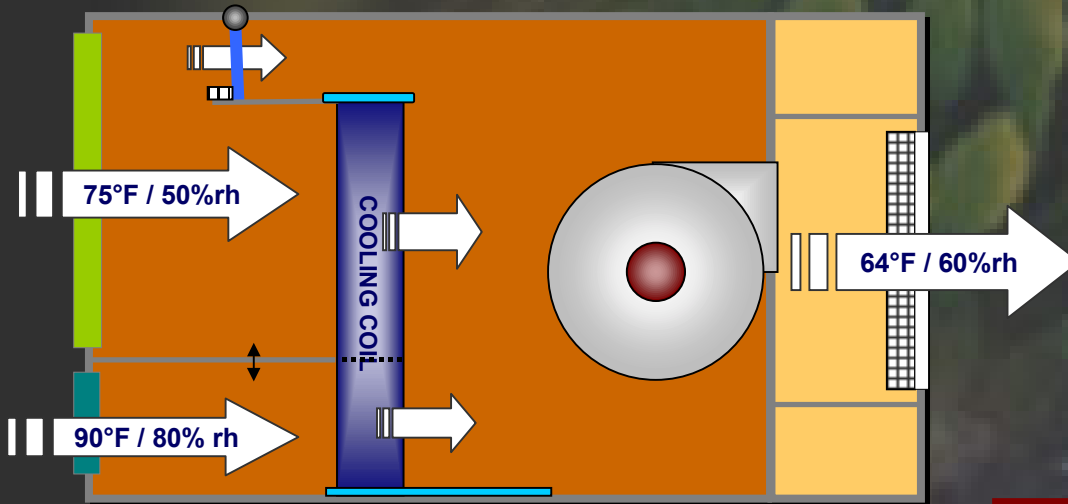
# Subcool Bypass

**Capacity 38**

**Latent 20**

**SHR 0.52**

**EER 10.2**



Condenser Coil

Liq-Suct  
HXGR

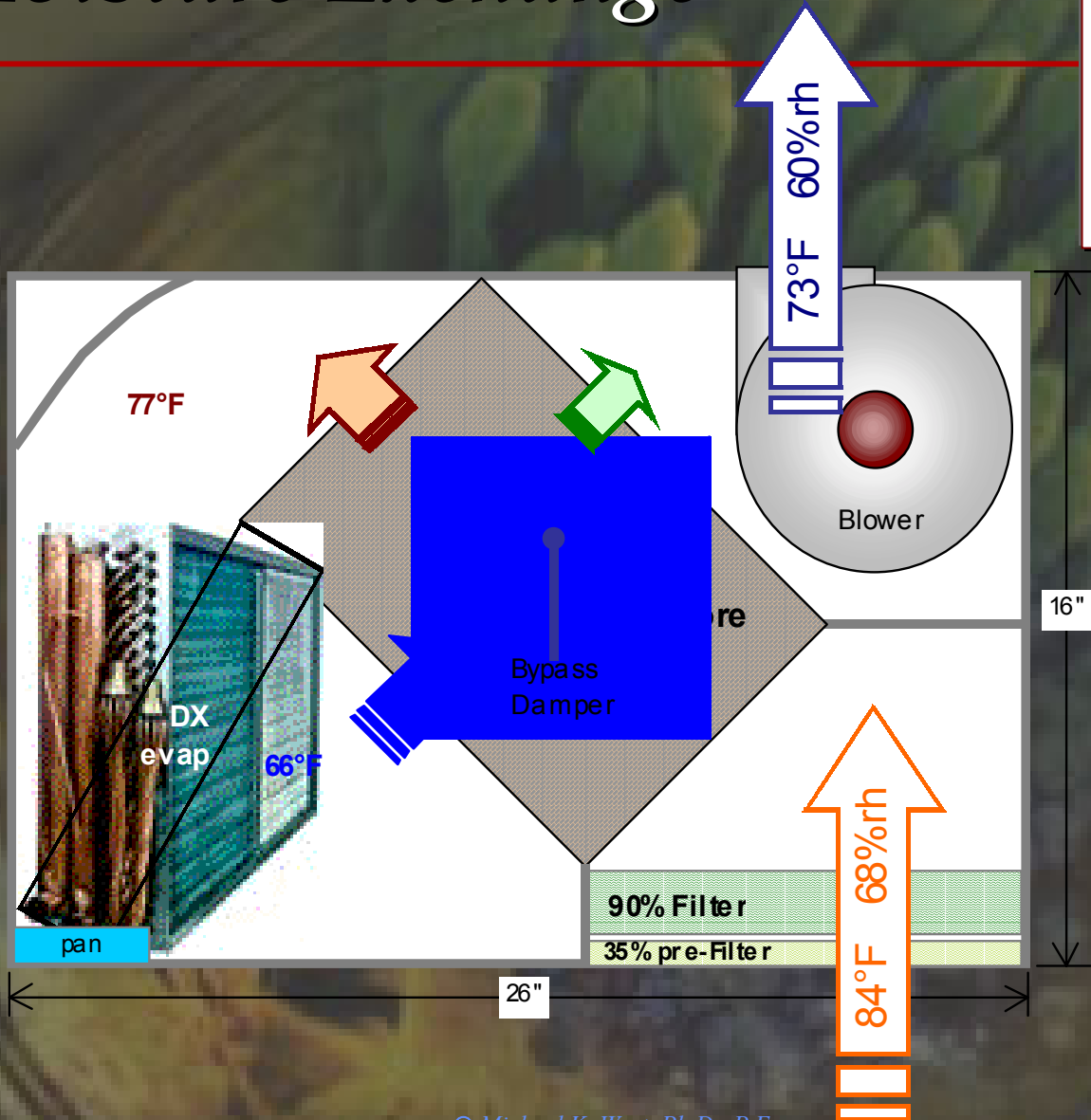
Compressor

Expansion  
Valve

Evaporator  
Coil

# Moisture Exchange

Capacity	40
Latent	22
SHR	0.45
EER	11.4



# Comparison

	<i>Total Capacity</i>	<i>Latent Capacity</i>	<i>SHR</i>	<i>EER</i>
	<b>MBH/kcfm</b>	<b>MBH/kcfm</b>	<b>Sen/Tot</b>	<b>MBH/kW</b>
<b>Standard</b>	<b>35</b>	<b>10</b>	<b>0.71</b>	<b>10</b>
<b>Electric Reheat</b>	<b>26</b>	<b>10</b>	<b>0.61</b>	<b>4.1</b>
<b>Hot-gas Reheat</b>	<b>23</b>	<b>13</b>	<b>0.42</b>	<b>6.6</b>
<b>Subcool Reheat</b>	<b>29</b>	<b>14</b>	<b>0.52</b>	<b>8.2</b>
<b>Heat Pipe Retrofit</b>	<b>34</b>	<b>17</b>	<b>0.50</b>	<b>9.7</b>
<b>Subcool Bypass</b>	<b>38</b>	<b>20</b>	<b>0.52</b>	<b>10</b>
<b>Moisture Exchange</b>	<b>40</b>	<b>22</b>	<b>0.45</b>	<b>11</b>

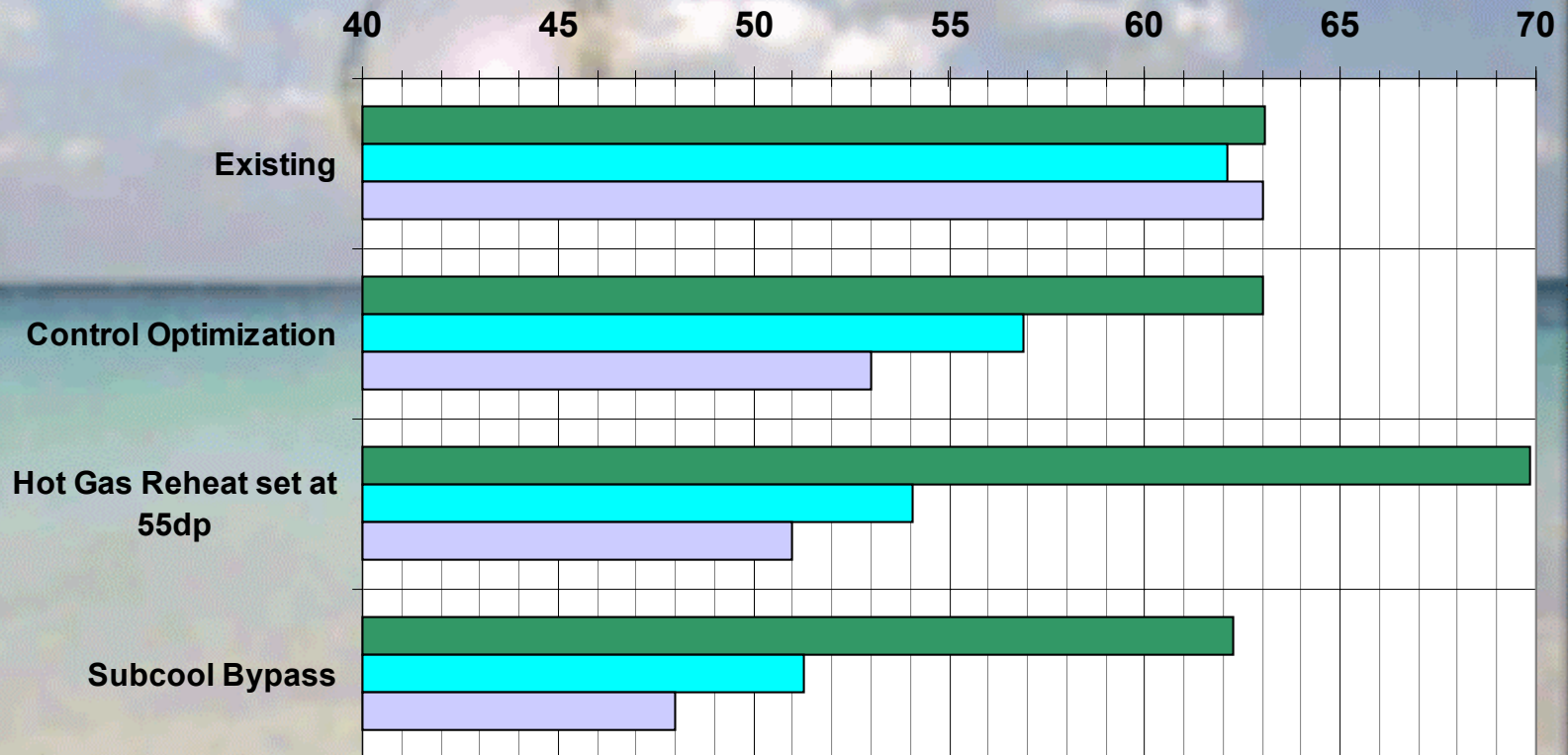
# CASE STUDY Comparison

■ Annual HVAC Electric Cost [\$1,000]

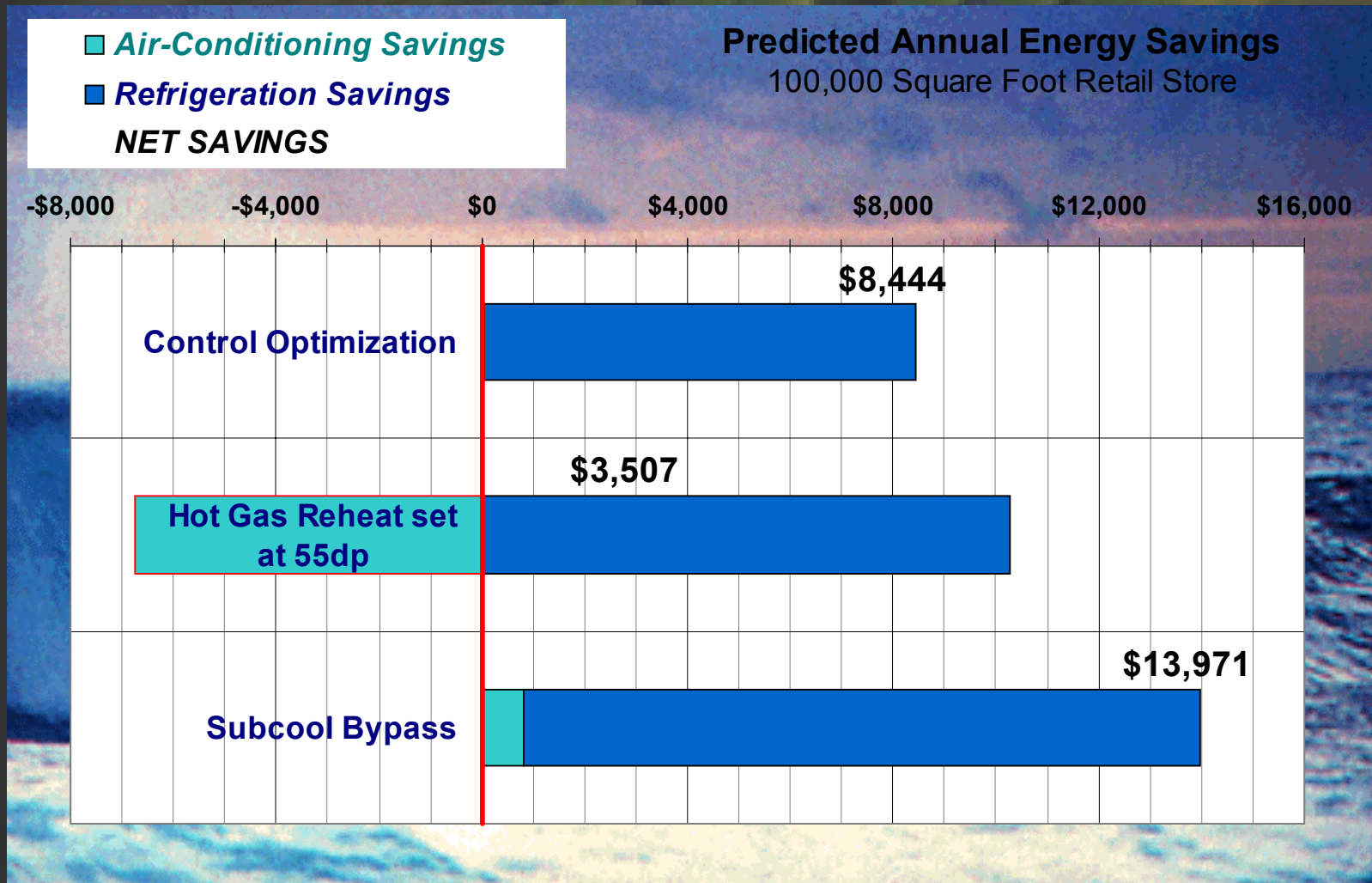
■ Max Dew Point [deg F]

■ Average Humidity [%rh]

Humidity Control Comparison  
100,000 Square Foot Retail Store



# CASE STUDY Comparison



# *Thank You!*

