DEFERRED MAINTENANCE

“The Cost Of Doing Nothing”

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INTRODUCTION

OVERVIEW

- Base Case Energy Model
- Factors Affecting Energy Performance: "**13 Point Checklist**"
- Worse Case Scenarios
- What Have We Learned?

INTRODUCTION

BACKGROUND

- Energy Model: Carrier Hourly Analysis Program (HAP) v.4.4
- ASHRAE 90.1 2004: Used as standard reference point
- Energy comparisons are based on cost
- Unless noted otherwise, energy differences our based on effect to energy consumption for entire building.

BASE CASE

BASE CASE

BUILDING DESCRIPTION

SAS Hall

N.C. State University

New building

Constructed 2009

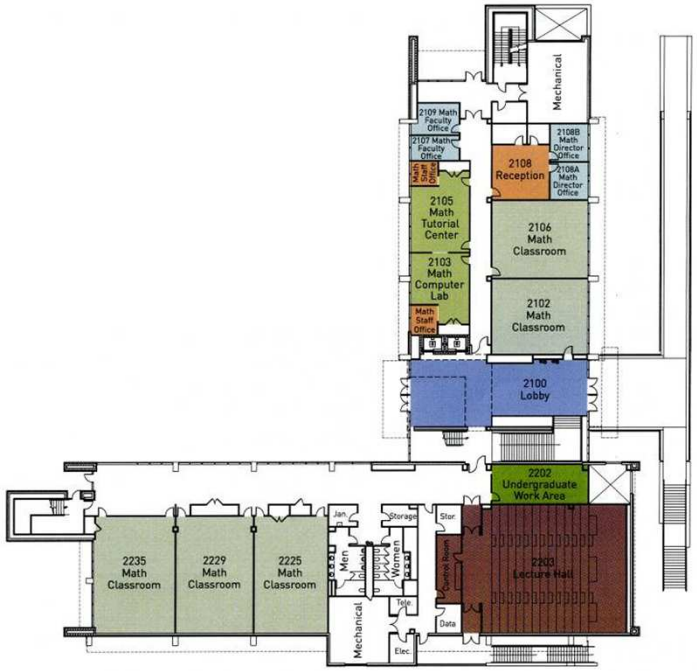
5-story

115,000 SF

Atrium

BASE CASE

BUILDING DESCRIPTION



General Classrooms

Faculty Offices

Lecture Halls

Facilities Operations Hub

BASE CASE

BUILDING DESCRIPTION

HVAC

- Two air handling units per floor
- VAV terminals with hot water reheat
- Campus chilled water & steam

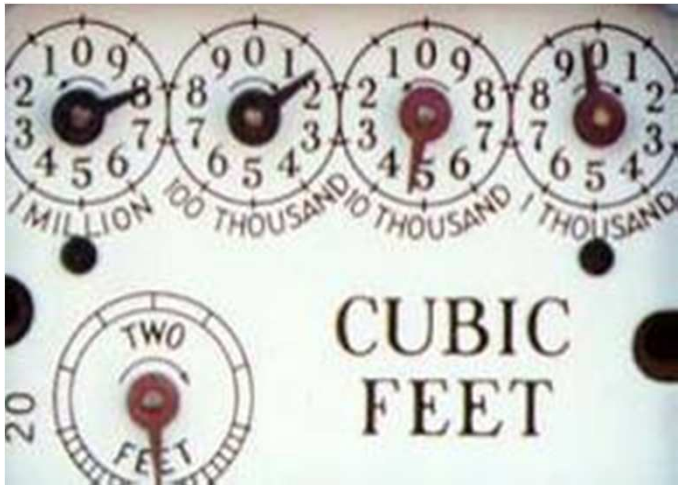
(however, for comparison purposes, the energy model has been adjusted for this presentation to be based on a building boiler and chiller system)

BASE CASE

BUILDING PERFORMANCE

Total Energy

Annual Cost = $ 164,200



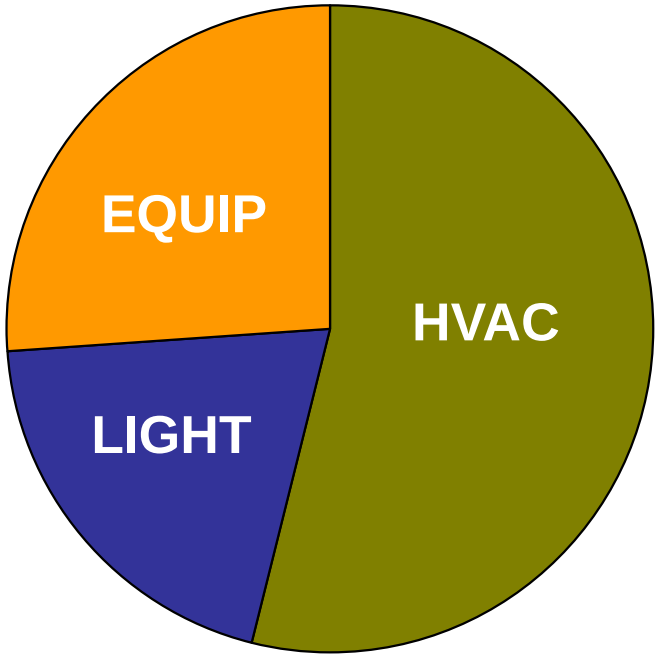
BASE CASE

BUILDING PERFORMANCE

Total Energy

Breakdown:

HVAC	54%
Lighting	20%
Equipment	26%



BASE CASE

BUILDING PERFORMANCE

HVAC Energy

Annual Cost = $88,467

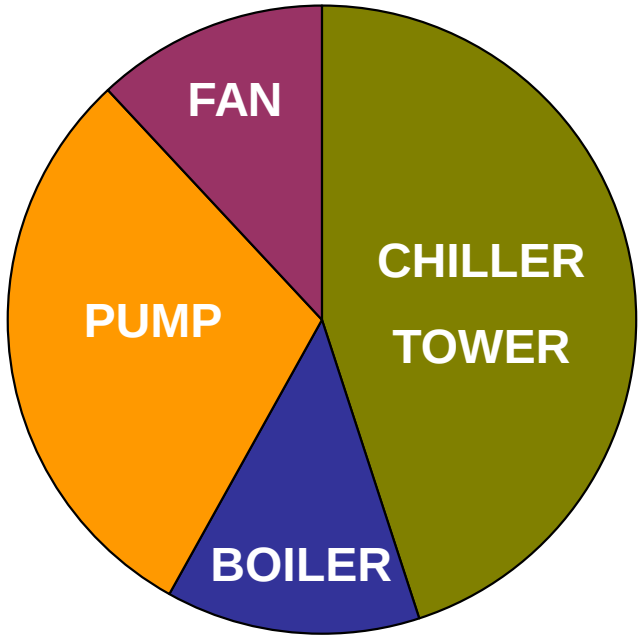
BASE CASE

BUILDING PERFORMANCE

HVAC Energy

Breakdown:

Chiller / Cooling Tower	45%
Boiler	13%
Pumps	30%
Fans	12%



THE CHECKLIST

THE CHECKLIST

FACTORS AFFECTING ENERGY PERFORMANCE

Maintenance Items

1. Lighting Controls
2. Filters
3. Fans
4. Pumps
5. Cooling Tower
6. Chillers
7. Boilers
8. Thermostats
9. Humidity Control
10. Night Setback
11. Outside Air Ventilation
12. Economizer Cycle
13. Schedule of Operations

FACTORS AFFECTING ENERGY PERFORMANCE

FACTORS AFFECTING ENERGY PERFORMANCE

LIGHTING

"Occupancy Sensor Malfunction"

Occupancy Sensor Light Control	Energy Difference
30% overage on light usage due to sensor failure	+6.8%

FACTORS AFFECTING ENERGY PERFORMANCE

LIGHTING

- Lighting usage obviously affects overall building energy performance.
- Lighting also influences energy consumption in other areas….

FACTORS AFFECTING ENERGY PERFORMANCE

LIGHTING

Lighting use overage of 30% impacts other systems:

Systems Affected	Energy Difference
HVAC	+1.6%

FACTORS AFFECTING ENERGY PERFORMANCE

HVAC EQUIPMENT

"Dirty Filters"

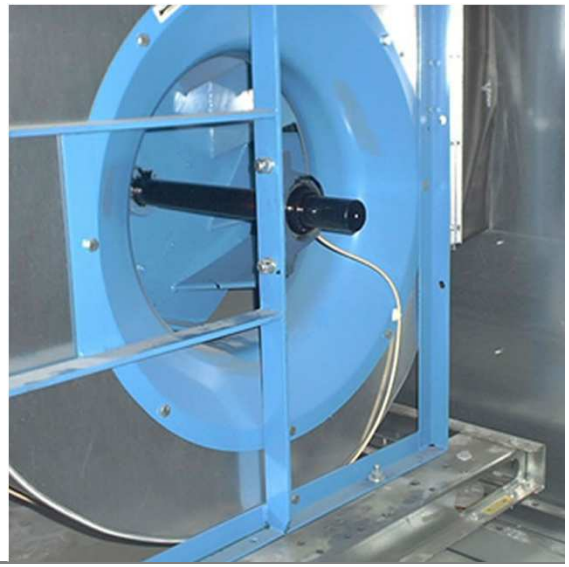
HVAC Equipment	Energy Difference
Dirty filters in AHU's (add 1" static pressure)	+4.1%

FACTORS AFFECTING ENERGY PERFORMANCE

HVAC EQUIPMENT

"Fan Speed Malfunction"

HVAC Equipment	Energy Difference
Variable speed fan runs constant volume	+8.4%

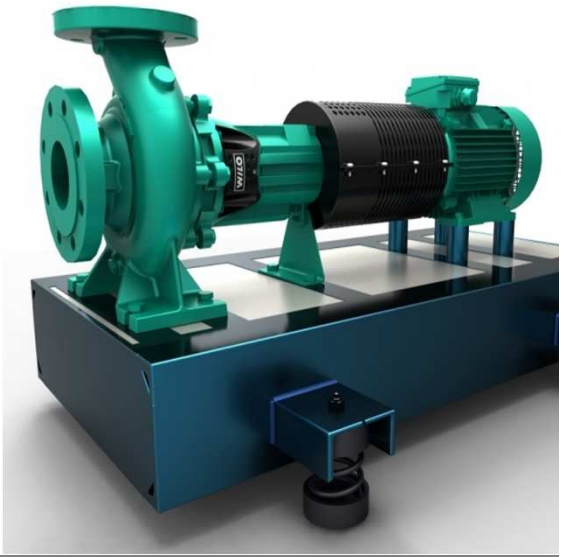


FACTORS AFFECTING ENERGY PERFORMANCE

HVAC EQUIPMENT

“Pump Speed Malfunction”

HVAC Equipment	Energy Difference
Variable flow pumping runs full speed	+10.6%



FACTORS AFFECTING ENERGY PERFORMANCE

HVAC EQUIPMENT

"Dirty Cooling Tower"

HVAC Equipment	Energy Difference
Fouled cooling tower (4 degree rise in condenser water temp)	+1.3%

- *For every 1 degree rise in condenser water temperature, chiller efficiency is lowered approximately 1.5%.*

FACTORS AFFECTING ENERGY PERFORMANCE

HVAC SYSTEM TYPES

"Chillers"

Problems	Energy Difference
Fouled tubes	+2.2%
Poor refrigerant charge	+3.7%

Per Brady Trane:

- *Fouled tubes create 10% (or more) loss in chiller efficiency*
- *Poor refrigerant change (over or under 10%) creates 17% loss in chiller efficiency*

FACTORS AFFECTING ENERGY PERFORMANCE

HVAC SYSTEM TYPES

"Boilers"

Problem	Energy Difference
93% efficient boiler acting like a 80% boiler	+4.0%

Per James M. Pleasants:

- *"US Department of Interior has established that a half inch of hard water scale-build-up on heat transfer surfaces can add up to 70% fuel costs for that piece of equipment"*

FACTORS AFFECTING ENERGY PERFORMANCE

HVAC SYSTEM TYPES

- Maintaining top chiller & boiler efficiency is a big deal.

FACTORS AFFECTING ENERGY PERFORMANCE

TEMPERATURE SETPOINTS

"Cooling"

Setpoint	Energy Difference
75 F (base case)	0
72 F	+ 3.0%
78 F	- 2.9%

FACTORS AFFECTING ENERGY PERFORMANCE

TEMPERATURE SETPOINTS

"Heating"

Setpoint	Energy Difference
70 F (base case)	0
72 F	+ 0.8%
68 F	- 0.5%

FACTORS AFFECTING ENERGY PERFORMANCE

TEMPERATURE SETPOINTS

- “Where the rubber meets the road”.
- Poorly functioning temperature sensors / thermostats affect performance.
- Drifting setpoints problematic

FACTORS AFFECTING ENERGY PERFORMANCE

HUMIDITY CONTROL

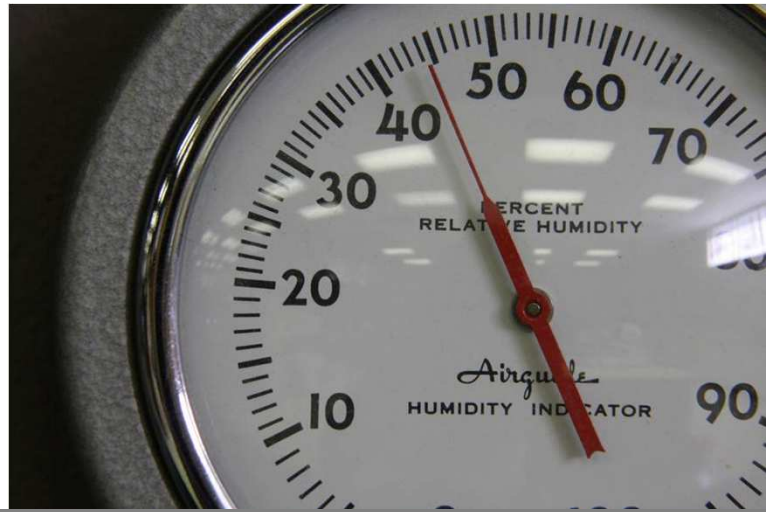
"Humidity control failure does more than just affect IAQ"

Control Setpoint	Energy Difference
No control	0
60% RH	+ 0.6%
50% RH	+ 2.3%
45% RH	+ 6.6%
40% RH	+17.9%

FACTORS AFFECTING ENERGY PERFORMANCE

HUMIDITY CONTROL

- Significant impact on building energy performance.
- Are your humidity setpoints verified and maintained?
- Is your humidity control system operating correctly?



FACTORS AFFECTING ENERGY PERFORMANCE

OFF-HOUR SETPOINTS

"What the building does while you sleep"

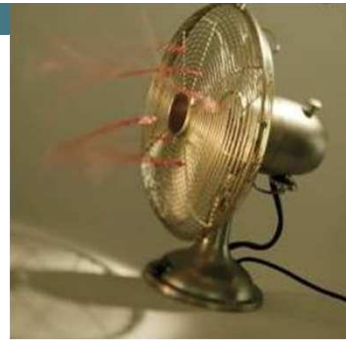
Night Setback Temperatures	Energy Difference
85 F cooling / 60 F heating (system operational)	0
Setback system failure	+ 6.4%

FACTORS AFFECTING ENERGY PERFORMANCE

OFF-HOUR SETPOINTS

- Failure to “dial it down” at night can dramatically affect your energy consumption.

FACTORS AFFECTING ENERGY PERFORMANCE



VENTILATION AIR

"Outside Air System Malfunction"

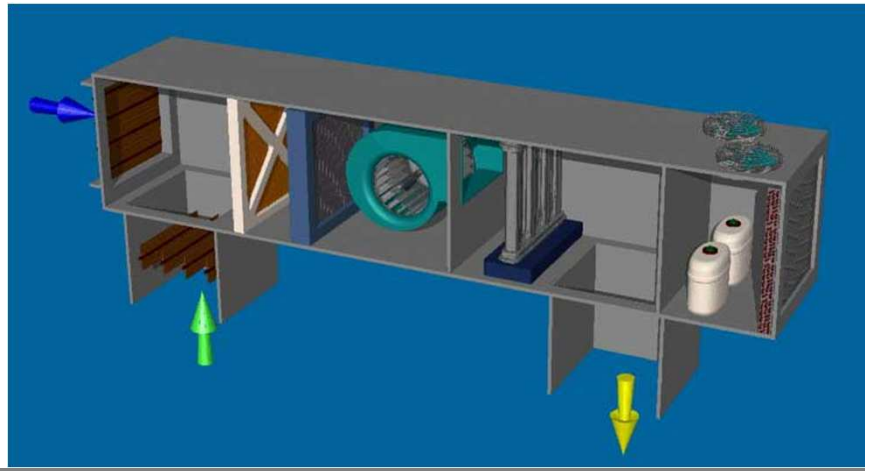
OA Quantity	Energy Difference
50% change from scheduled OA amount	8.2%

FACTORS AFFECTING ENERGY PERFORMANCE

VENTILATION AIR

"Demand Control Ventilation"

OA Control Type	Energy Difference
CO2 sensor failure (OA levels not reduced)	+2.0%



FACTORS AFFECTING ENERGY PERFORMANCE

VENTILATION AIR

- Ventilation system performance significantly affects building energy usage.

FACTORS AFFECTING ENERGY PERFORMANCE

AIR-SIDE ECONOMIZER

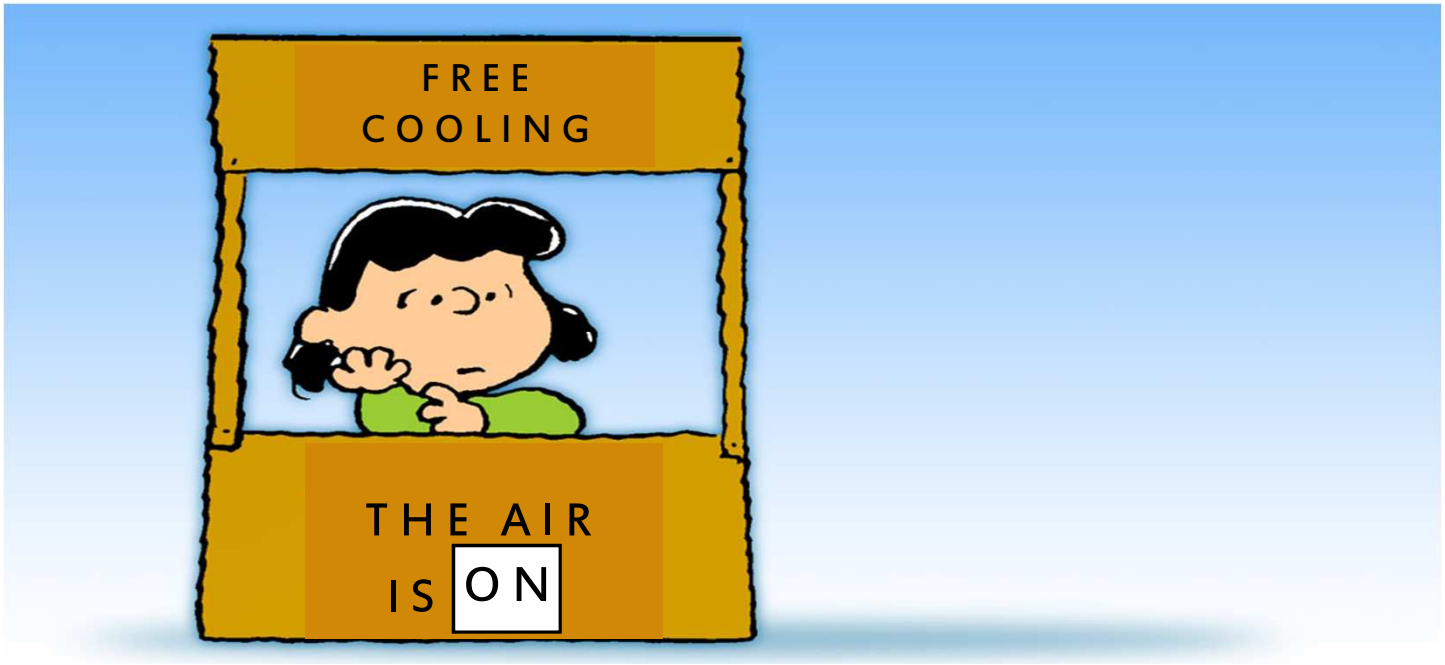
"You can't save $ if it doesn't work"

Economizer Cycle	Energy Difference
Not operational	+1.4%

FACTORS AFFECTING ENERGY PERFORMANCE

ECONOMIZER

- Free cooling certainly helps, but only when economizer works.



FACTORS AFFECTING ENERGY PERFORMANCE

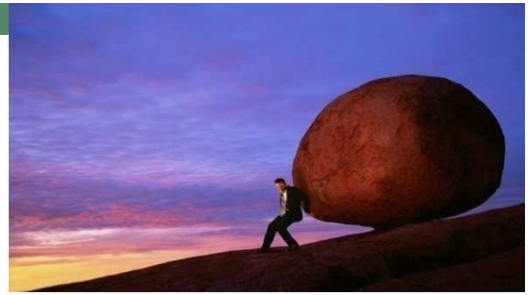
SCHEDULE OF OPERATIONS

“So what if my time clock if off by an hour…”

Change In Operations	Energy Difference
One extra hour of building usage (on average)	+ 3%

WORSE CASE SCENARIO

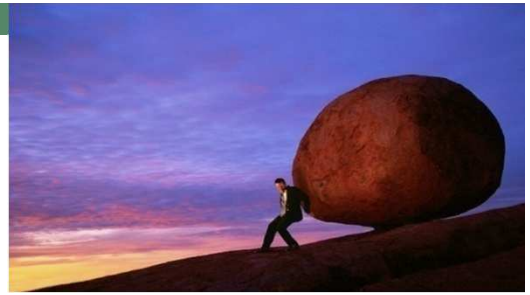
WORSE CASE SCENARIO



OPERATION COMPARISON

	Best Case	Worse Case
Light Sensor	OK	30% overage
Filters	Clean	Very Dirty
Fans	Variable Speed	Full Speed
Pumps	Variable Speed	Full Speed
Cooling Tower	OK	Fouled
Chiller	OK	Fouled, Poor Charge
Boiler	OK	Efficiency Loss

WORSE CASE SCENARIO



OPERATION COMPARISON

	Best Case	Worse Case
Thermostats	OK	3F drift
Humidity	50%	40%
Night Setback	OK	Disabled
Outside Air	OK	50% overage, no demand
Economizer	OK	Disabled
Schedule	OK	1 hour off
Energy	**$ 164,000**	**$ 297,852**
		81.4 % increase

SUMMARY

SUMMARY

DEFFERED MAINTENANCE IMPACT

Annual Effect on Energy Cost

1 – 5%

- Dirty filters
- Fouled cooling tower
- Boiler efficiency loss
- T’stat setpoint drift
- Economizer
- Schedule

5+%

- Lighting control
- No fan speed control
- No pump speed control
- Chiller fouled & mischarged
- Humidity control
- Night set back
- OA ventilation rate overage

CONCLUSION

“THE COST OF DOING NOTHING”

- Maintainable systems (mechanical & electrical) use approximately 75% of building energy
- Ignoring maintenance of building systems can increase energy usage significantly

THANK YOU FOR YOUR TIME