

Development of Energy Efficiency Best Practices in Hotel Buildings

Sustainable Energy Management Seminar

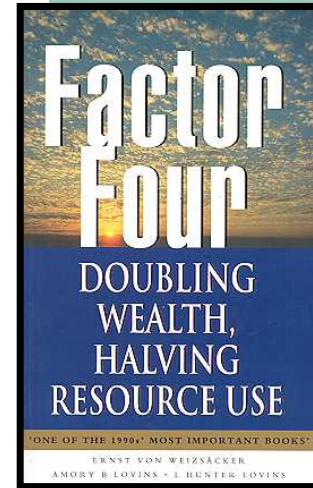
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There is no better time !!!

- Rising Energy Tariffs. ~50% Increase !!
- Better Investment Returns (>30% ROI)
- Reduced Risk: Adopt New Proven Ideas
- 50% Grants for Energy Efficiency Audits
- ESCO Accreditation Process **

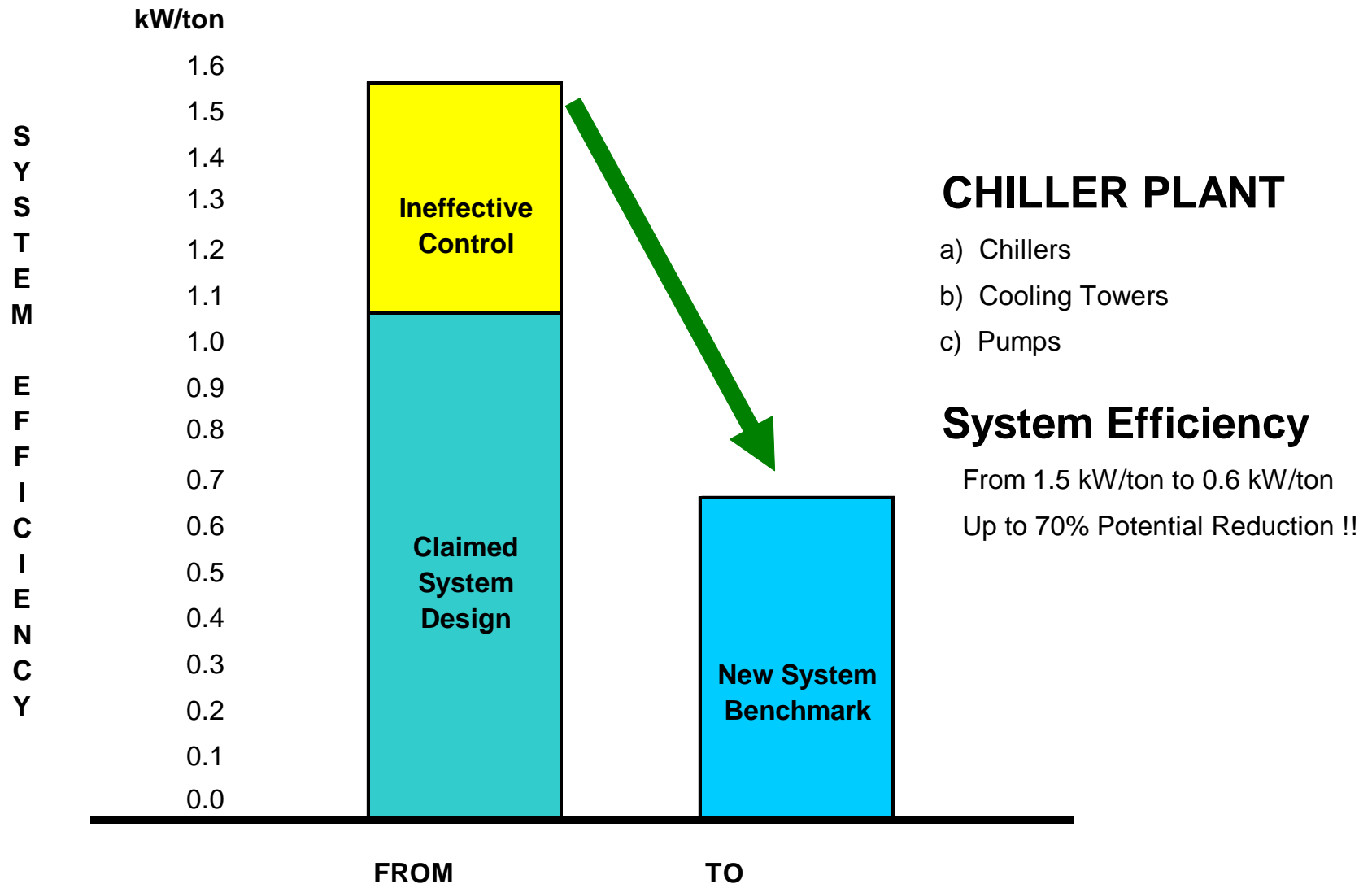
** **Note:** Accredited ESCOs based on years of experience in Energy Audits. It does not take into account ESCO's capability to deliver the claimed performance.



Energy Efficiency Opportunities

1. HVAC System 
2. Lighting
3. Monitoring and Control Systems
4. Refrigeration and Cold Rooms
5. Hot Water System (Heat Pumps)
6. Laundry / Dishwashing Equipment
7. Vertical Transportation (Elevators and Escalators)
8. Appliances (Green Label)
9. Swimming Pools, Spa Pools, Water Features

(1) SYSTEM DESIGN + (2) SYSTEM CONTROL = SYSTEM PERFORMANCE



HVAC System

Adopt Total System Design (not piece meal)

- Right sizing of Equipment
- High Efficiency Chillers Refrigerant (123 vs. 134 A)
- High Efficiency Pumps (on all pumps and fans with long run hours)
- Oversized Cooling Towers
- Variable Air Volume (VAV) distribution system
- Variable Speed Drives on Cooling Towers in response to variable loads
- Insulation on Chilled Water Piping
- Heat Recovery: Obtain free hot water from chillers
- Control Outside Air Intake when Enthalpy is High (i.e. too much intake on hot and humid intake)
- Intelligent Energy Management System (EMS) and Real Time Monitoring
- Defining Comfort (Temperature, Humidity, Ventilation)

NEW

BENCHMARKS:

- **Central Plant :**
0.60 kW/ton
including cooling towers and pumps
- **Outside AHUs :**
0.03 kW/ton

Lessons Learned

Mistakes continue because bad designs known to "work" are simply copied and seldom questioned. (Natural Capitalism)

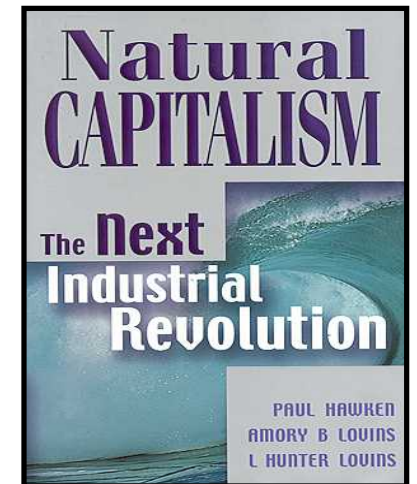
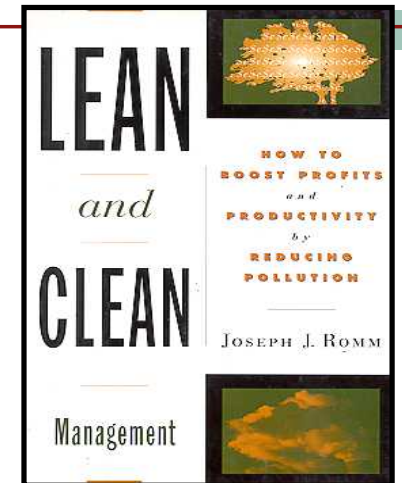
Many chillers and pumps are grossly oversized

Piecemeal approach: Components not be working optimally as a system

Accurate Measurements: Actual needs are measured, not guessed

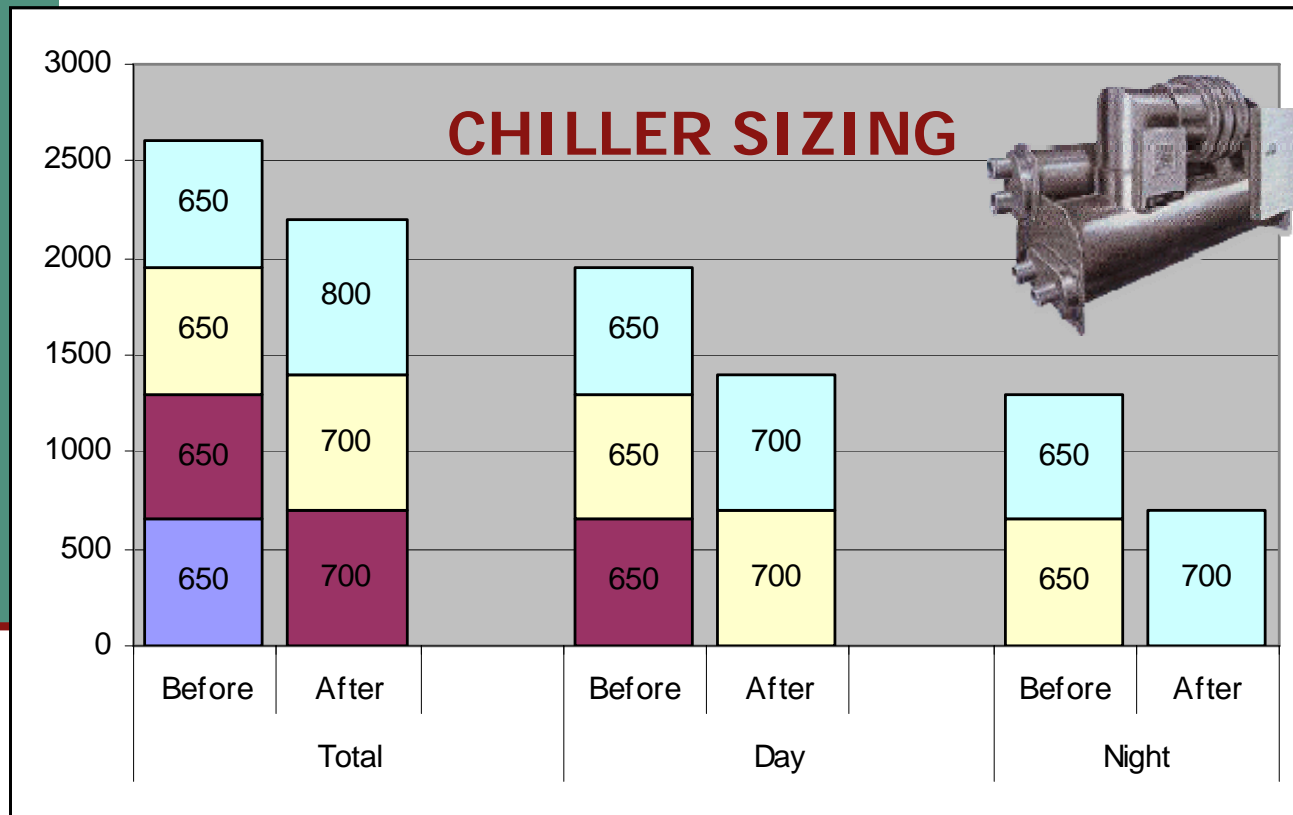
Real Time Monitoring: Any deviation from design specs can be quickly identified and rectified, instead of being unattended to

Invest on "Least Life Cycle Cost", not Lowest Initial Cost.



Lessons Learned

Design Approach: Conventional vs Total System



AVOID “One-to-one” Replacement

Hotel reduced its Investment Cost by **~\$500,000** by right-sizing the equipment and doing away with unnecessary pumps and valves

Day tonnage reduced by 450 tons (~28%). Night tonnage reduced by 600 tons (~46%)

- Lower Investment Cost
- Lower Operating Cost
- Lower Replacement Cost

Psychrometric Conditions

TEMPERATURE vs. HUMIDITY

gms OF WATER PER kg OF DA

30.0000

Outside Air

OA-AHU Reheat

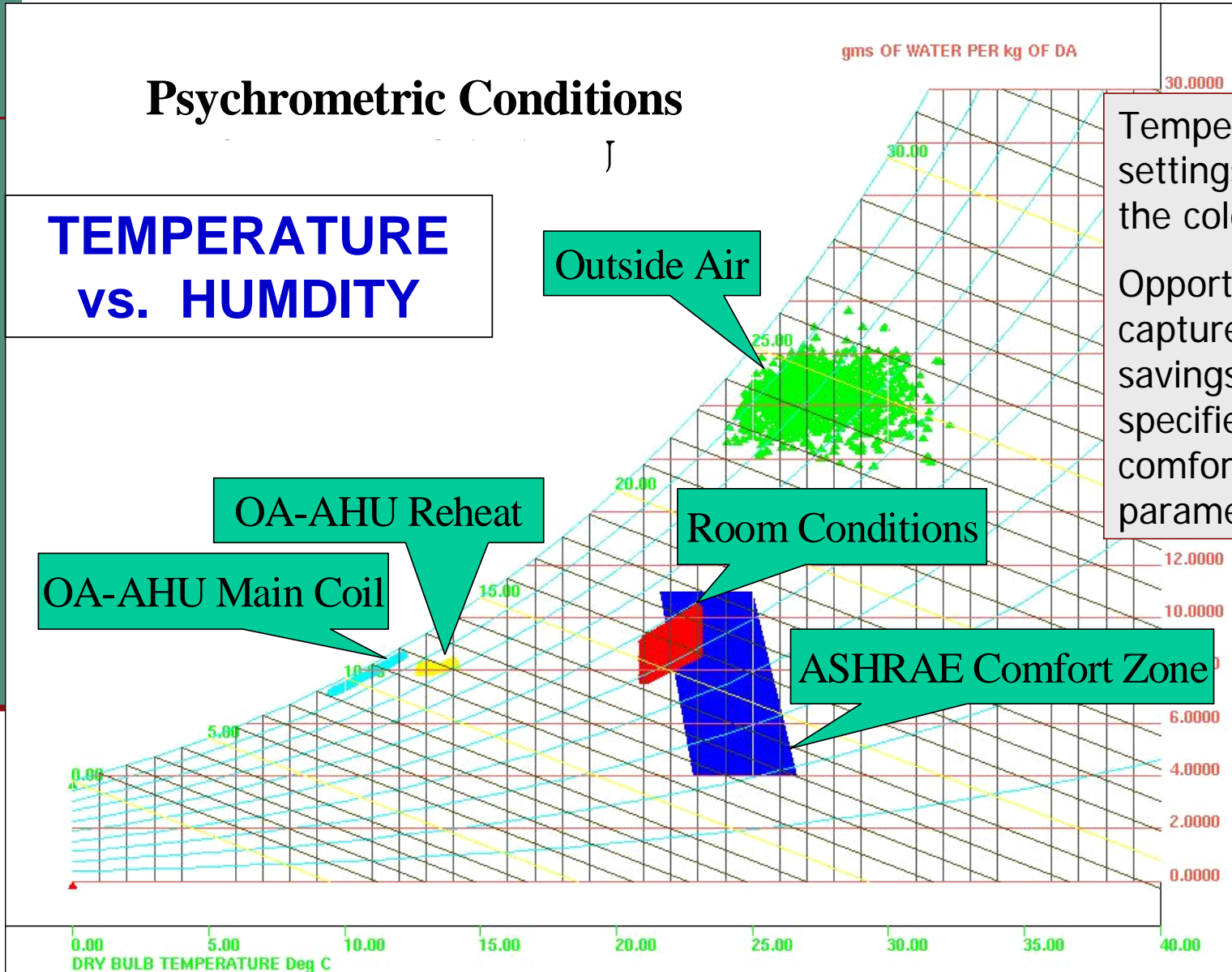
OA-AHU Main Coil

Room Conditions

ASHRAE Comfort Zone

Temperature settings was on the cold side.

Opportunity to capture further savings within specified comfort parameters.



Lighting

lawrence berkeley national laboratory

environmental energy technologies division

building technologies department

lighting research group

LIGHT DISTRIBUTION SYSTEMS



The lighting research group at Lawrence Berkeley National Laboratory performs research aimed at improving the energy efficiency of lighting systems in buildings and homes, throughout California and across the nation. The goal is to reduce lighting energy consumption by 50% over twenty years so that it is available, where and when needed, and at the required intensity.

Please click on an image for more information.

CONTROLS AND COMMUNICATIONS



SOURCES AND BALLASTS



HUMAN FACTORS

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[SOURCES AND BALLASTS](#) [LIGHT DISTRIBUTION SYSTEMS](#) [CONTROLS AND COMMUNICATIONS](#) [HUMAN FACTORS](#)

LAWRENCE BERKELEY

**Reduce Lighting
Energy
Consumption by
50% over 20 years**

Lighting

1. More Efficient Lighting Fixtures
 - Compact fluorescent lighting (CFL),
 - LED lamps,
 - High Intensity Fluorescent (HIF) lighting

 - 40 – 80% savings
 - Today, both linear and CFL can now be dimmed using special dimming ballasts and have colours that closely match incandescent lamps

2. Improved Lighting Controls
 - Computer Controlled / Lighting Management Systems
 - Key Tag Systems, Occupancy Sensors, Photocell Controls

3. Lighting Design (Incorporate into Building Design)
 - Using Daylight, Colors, Intercepting and Redirecting Daylight

Stewarding

Energy Efficient Dishwashers

- Reduced energy consumption
 - First load is heated using water mains
 - Subsequent loads are heated using heat exchanger which stores hot water from the final rinse cycle and steam generated in every wash phase
- Reduced water consumption by 50%
- Reduced chemical consumption

Laundry And Dry Cleaning

- Use Energy Efficient Equipment
- Ozone laundering ?
 - Reduced chemical consumption
 - Require Lower Water Temperature
- Heat Pumps ?
- Operations
 - Washing with Full Loads
 - Using Premium Detergents that requires Lower Water Temperature

WHY MANY CURRENT PROJECTS DON'T DELIVER ? (1 of 2)

Recent retrofits are still far off the benchmark set in 2001 (i.e. Chiller Plant Efficiency of 0.58 kW/ton including pumps). Our Standard today is 0.75 kW/ton for Chiller Plant without pumps. Why?

ESCO: Selection based on Price and not Value Created (i.e. Efficiency - not Service Denial; ROI or Least Life Cycle Cost)

- No proper check on Track Record
- Lack of Verifiable Data.
- **Design:** Old design paradigm continues. Lack of emphasis on Total System Design based on Efficiency.
- **Equipment:** Selection based on Lowest First Cost, Not Least Life Cycle Cost.

WHY MANY CURRENT PROJECTS DON'T DELIVER ?

(2 of 2)

■ Contracts

- No Measurement Required
- No Performance Guarantee Required

■ No Accountability by Esco and/or Vendors

Example: Different consultants for Audit, Design, and Construction. Lack of accountability when things go wrong. Everyone blames everyone. Claims are difficult to enforce. Truth is swept under the carpet.

Key Factors of Success

1. **Get the Right People (Internal Team)**
2. **Seek the right ESCO**
 - Check Track Record based on performance measurements
 - Insist on Performance Guarantees
 - Verify Post Retrofit Performance
3. **Adopt Total System Design Approach**
 - Focus on Design, not Piecemeal or Gadgets
 - Deal with Facts brutally
 - Be open to New Proven Ideas
 - Establish Proper and Accurate Measurement System

KEY FACTORS OF SUCCESS

1. Getting the Right People (Internal Team)

This is the first CRITICAL STEP.

Owners

- Decision Maker
- Managing Director / Finance Director
- Owner's Representative

Internal Management Team

- General Manager
 - Director of Engineering / Facilities Manager
 - Director of Finance / Business Support
 - Asset Manager / Business Analysts
-
- Getting the Decision Makers to understand the commercial value
 - Getting the Technical Team to be more opened to new proven solutions.

KEY FACTORS OF SUCCESS

2. Selecting Your E\$CO

2.1. CHECK TRACK RECORD

- Number of successful projects (and failures).
- Load reduction (before vs. after).
 - System design + Control measures taken
 - Enhanced Comfort or Service Denial
- Monitoring software and System efficiency performance
 - Savings achieved (*How is it measured? Is it accurately measured?*)
 - Bring verifiable data (e.g. Measurements + Utility Bill)
- Project ROI and Payback

2.1. Analysing ESCO proposal

	Current <i>Baseline</i>	Targeted Improvement	Actual Results	\$ Saving
1. Chillers				
2. Cooling Towers				
3. CHW Pump				
4. CW Pump				
Chiller Plant				

2.1. Establishing Commercial Returns

	Year 0	Year 1	Year 2	Year 3	...	Year 10	...	Year 15
Initial Cost								
Project Cost								
Less: Tax Incentives / Grants								
Net Project Cost								
Savings								
Energy Savings								
Water Savings								
Maintenance								
Replacement Cost								
Sub-Total 1								
Other Benefits								
Space Recovery								
Brand Enhancement / Brand Protection								
- Improved Comfort								
- Improved IAQ								
- Improved Occupancy / Average Rates								
- Marketing Value								
Productivity Improvement								
Sub-Total 2								
Combined Total								
Financial Returns								
Incremental Cash Flow								
Return on Investment								
Payback								
IRR								
NPV								

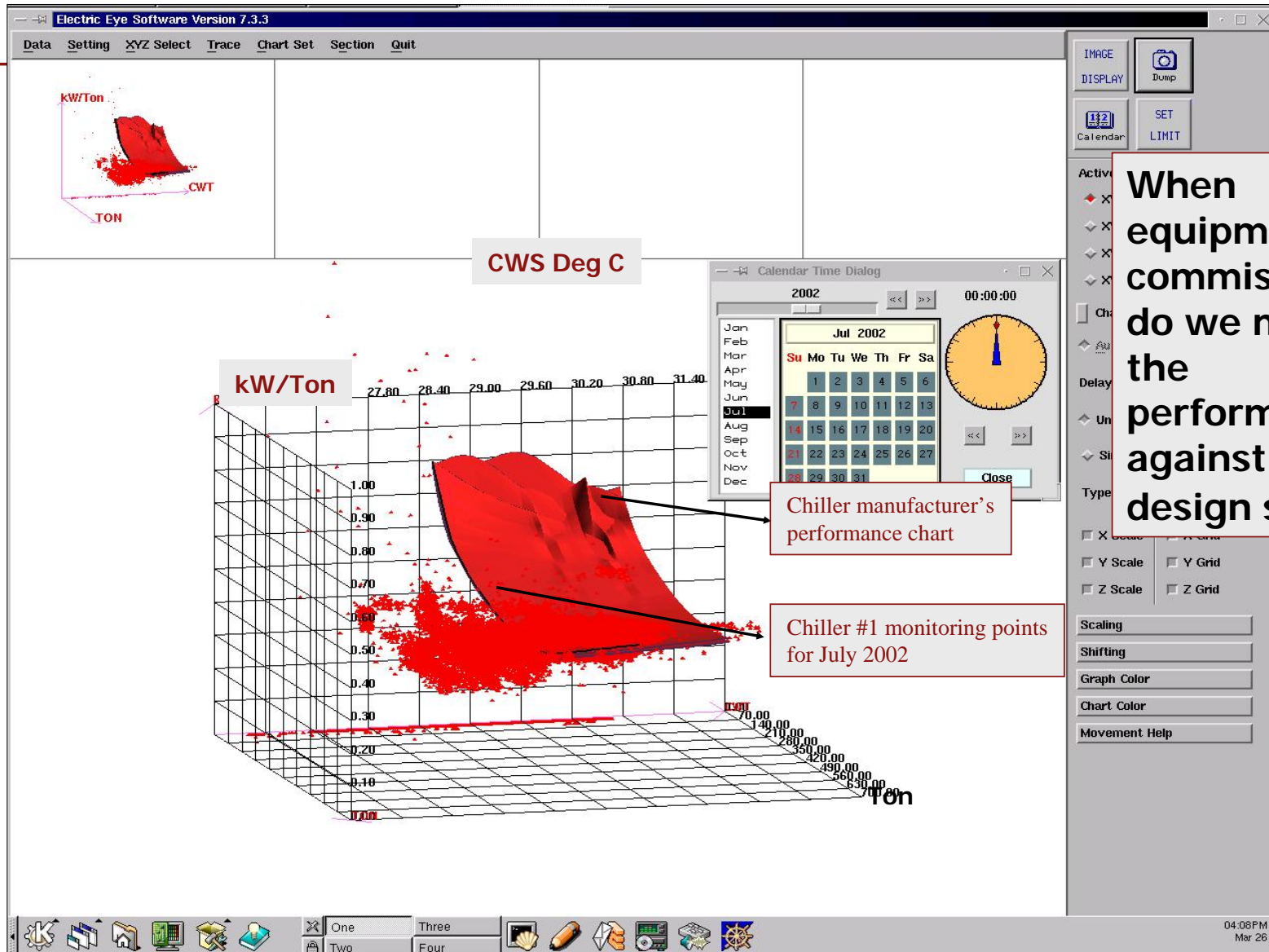
Do not buy on lowest first cost.

Rather assess the lowest life-cycle cost

2.2. Insist on Performance Guarantees

- Why should we have a Performance Guarantee
- Do we measure post retrofit performance?
- What is the penalty of Non-Performance?
 - Fee Reduction (limited recourse)
 - Penalty equivalent to shortfall amount over a period of up to 5 years
- Must we pay for a performance guarantee?

2.3. Verify Post Retrofit Performance



2.3. Verify Post Retrofit Performance

source: www.nccc.gov.sg/building/GEM.pdf

- Central Plant (Factor 2): **0.58 kW/ton** including cooling towers and pumps
- Outside AHUs (Factor 10): **0.029 kW/ton**

Step 1: Establish Energy Efficiency Performance
based on Readings from Monitoring System

	Before Retrofit	After Retrofit	Efficiency Improvement
Chillers	0.750 kW/ton	0.466 kW/ton	61% improvement
Cooling Towers	0.030 kW/ton	0.029 kW/ton	See Note 1 below
CHW Pump	0.152 kW/ton	0.033 kW/ton	3.6 X improvement
CW Pump	0.118 kW/ton	0.032 kW/ton	2.7 X improvement
Central Plant	1.050 kW/ton	0.560 kW/ton	88% improvement
Outside AHUs and Exhaust Fans	0.318 kW/ton	0.0290 kW/ton	10.0 X improvement

2.3. Verify Post Retrofit Performance

STEP 2: COMPUTE (THEORETICAL) \$ SAVINGS

	AVE MONTHLY USAGE		AVE MONTHLY SAVINGS		ANNUAL SAVINGS	
	Before kwh	After kwh	kwh	% Saved	\$	% of Total Savings
Energy Consumption						
Parasitic load reduction	136,875	-	136,875	100%	\$197,100	16.2%
Chillers	574,875	367,920	206,955	36%	\$298,015	24.5%
Pumps & towers	284,700	51,830	232,870	82%	\$335,333	27.6%
Outside AHU and Ex fans	58,035	5,293	52,742	91%	\$75,948	6.2%
Podium ahu (partial)	29,600	9,600	20,000	68%	\$28,800	2.4%
Sub-Total HVAC	1,084,085	434,643	649,442	60%	\$935,196	77.0%
Water fall kw	32,607	15,087	17,520	54%	\$25,229	2.1%
Domestic water pumps	13,614	7,920	5,694	42%	\$8,199	0.7%
Sub-Total	1,130,306	457,650	672,656	60%	\$968,625	79.7%
Max Demand	kw	kw	kw	%	\$	% of Total Savings
Parasitic load reduction	263	-	263	100%	\$28,382	2.3%
Chillers	788	504	284	36%	\$30,652	2.5%
Pumps & towers	315	105	210	67%	\$22,705	1.9%
Outside AHU and Ex fans	80	7	73	91%	\$7,893	0.6%
Podium ahu (partial)	56	18	38	68%	\$4,152	0.3%
Sub-Total HVAC	1,501	634	867	58%	\$93,783	7.7%
Water fall	67	31	36	54%	\$3,892	0.3%
Domestic water pump	55	22	33	60%	\$3,568	0.3%
Sub-Total	1,623	687	936	58%	\$101,244	8.3%
Water Saving	m3/month	m3/month	m3/month	%	\$	% of Total Savings
Cooling towers	9,934	4,550	5,384	54%	\$145,364	12.0%
COMBINED					\$1,215,232	100.0%

Chillers contributed only ~27% of total savings

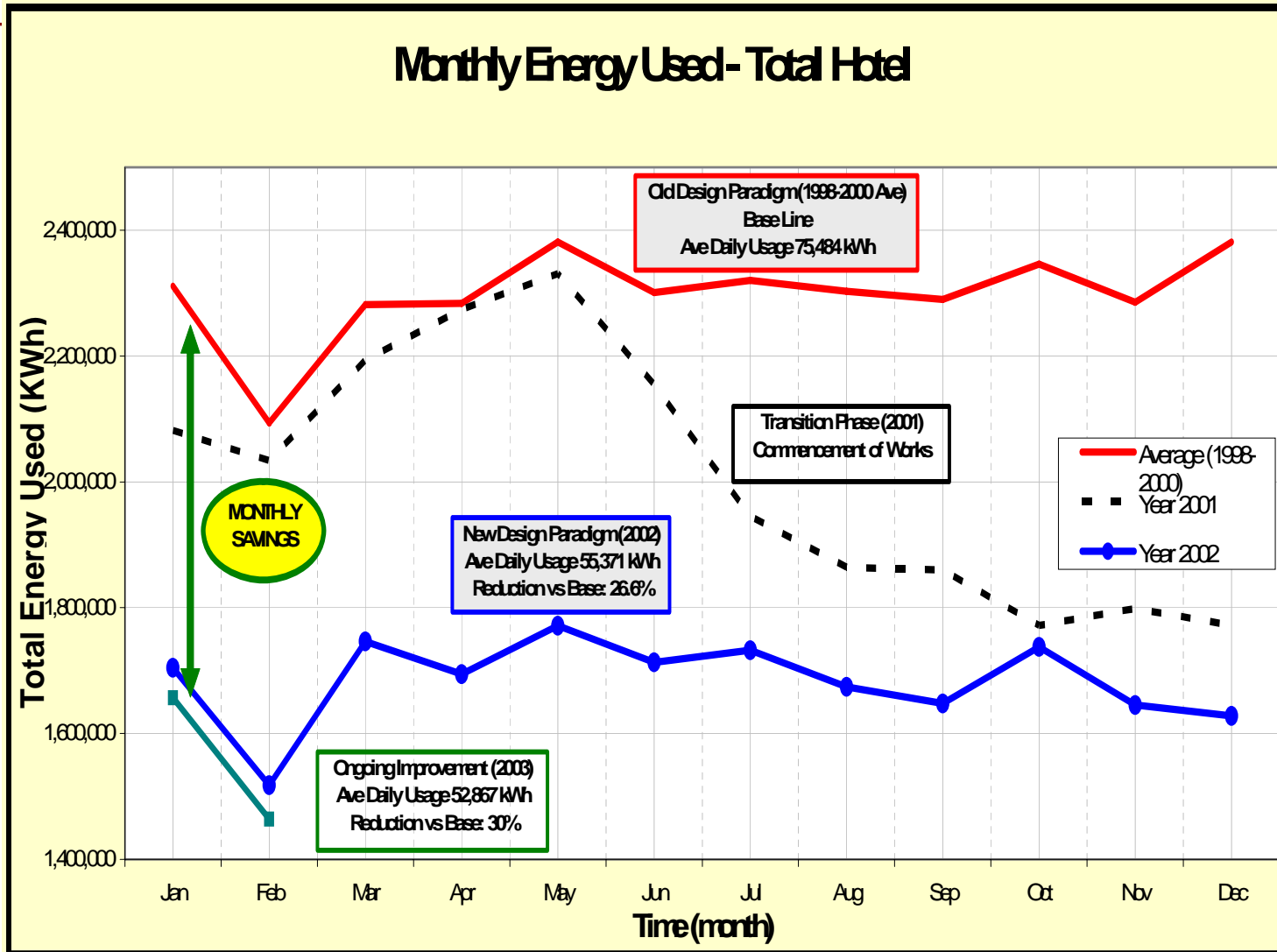
What about the balance 73%?

Without the total system approach, the savings from the new chillers will even be less

Note: \$ Savings are based on base-line tariffs established at end 2000 prior to project implementation

2.3. Verify Post Retrofit Performance

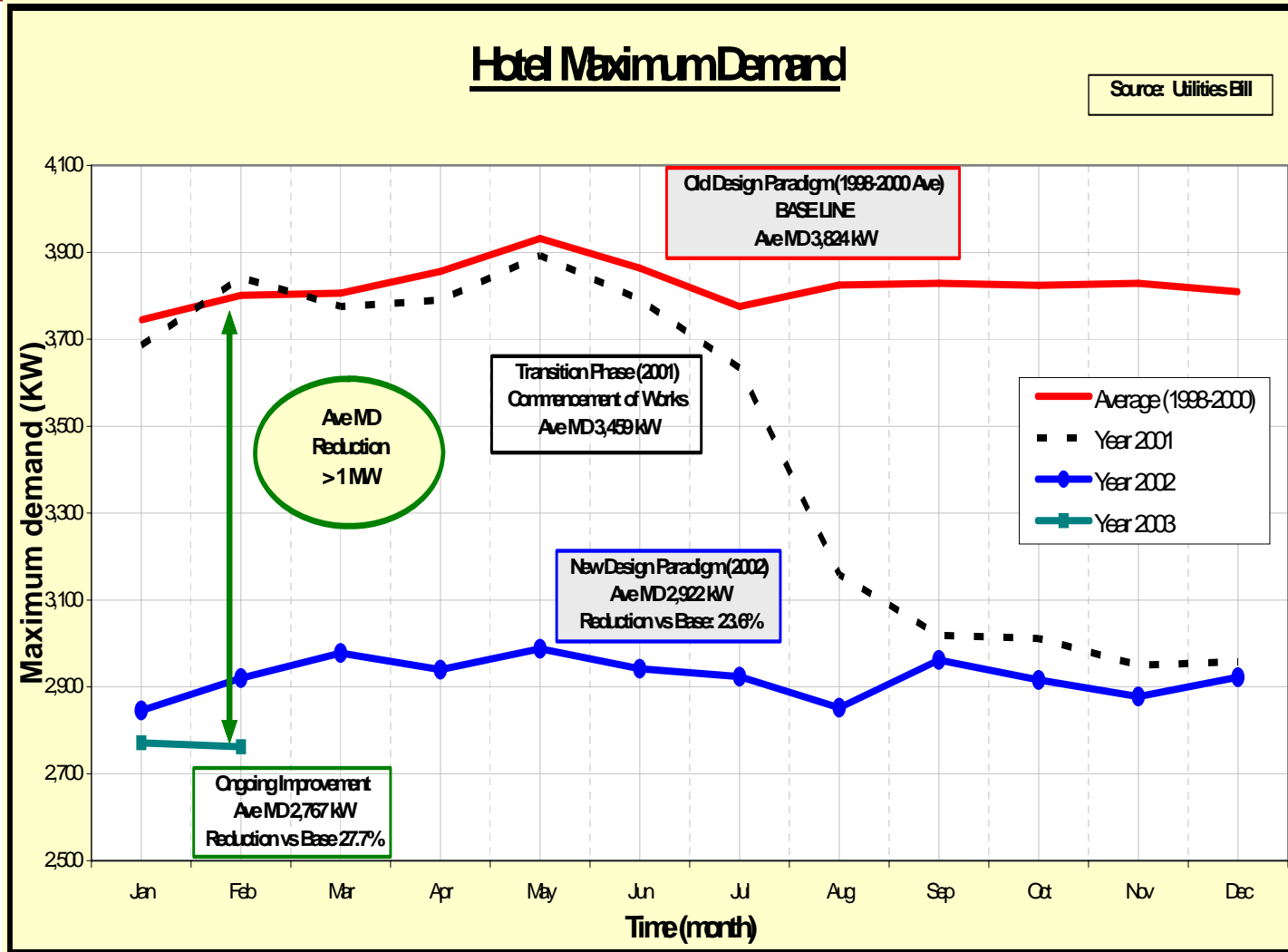
**Step 3: Cross Check
against Utilities Bill**



Do the numbers stack up?

2.3. Verify Post Retrofit Performance

Step 3: Cross Check against Utilities Bill



Do the numbers stack up?

CONCLUSION: INVEST WISELY

Treat Energy Efficiency as an “investible” project.

- Select the Right People Internally
- Select the Right ESCO Team
- Do not necessarily go for the cheapest solution (i.e. lowest first cost).
- Seek the solution that provides :
 - the least life-cycle option,
 - maximizes your \$\$ return
 - Provides performance assurance
 - Enhances Comfort and IAQ
(and not Service Denial)



**Enhanced
Asset Value**

Looking Forward: *What could be Next?*

- Creating a Centre of Excellence
- Measurements: Establish Verification Process / Service
- ESCO Grading: Based on verified performance
- Provide best practices and relevant information on the Web
- Choice of HVAC refrigerant: 123 vs. 134A. Greenhouse Gases (Kyoto) vs. Ozone Depletion (Montreal)
- Provide More Incentives for Companies and Hotels to Go Green:
 - Tax Incentive (Double Tax Credits for Energy Efficiency Projects)
 - Grants / Rebates for Energy Efficiency Projects (e.g. if lower than 0.70 kW/ton for Chiller Plant inclusive of pumps)
 - Additional Incentives for Showcase Projects