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Enterprise Technology Solutions

eco Friendly Data Centers

September 7, 2011

Introduction

Opening Remarks:

-**Margo Springs**, Director ETS

-**Jack Johnson**, Deputy Director ETS

-**Ron Zemites**, ETS IT Assist Manager

-**Hank Crenshaw**, ETS Systems Analyst

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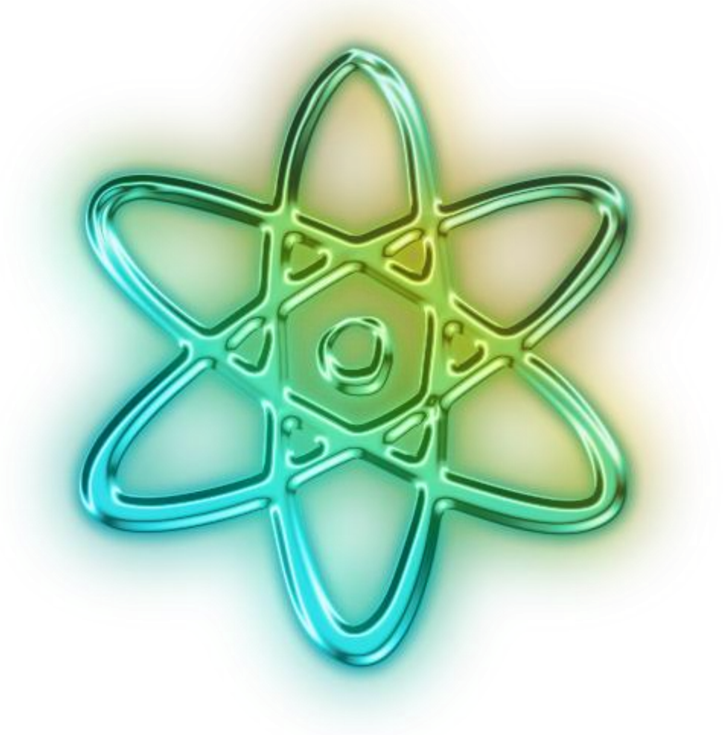
First Things First



- It is important to know exactly what your goal is and focus on that.
- Look at ways to cut without keeping in the equation what you need will not do any good.
- There are ways to do most anything you need to do but you need to know your constraints first.

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Magic Wand - Quick Fix

If you're looking for

a Magic Wand or

One Size Fits All,

Good Luck-

There is NO such thing!

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The Best for your Needs

- Take what you have and do the best you can for your needs.
- Determine how much Vendor tools will increase your load or how much it will cost to implement their solutions.

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The $ of Solutions

Will the solution be at a cost to you?

There is a balance and a variety of tools available to reduce energy strain without necessarily implementing a solution that may or may not be beneficial.

Effective Business

- Be conscious that making business more efficient can result in clients wanting to take advantage of those savings thereby increasing your need.
- There must be restraint to not add virtual servers simply because they are cheap.

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Everyone Wants to be Eco-Friendly

Evaluate how strong a solution you need to meet the size of your demands.

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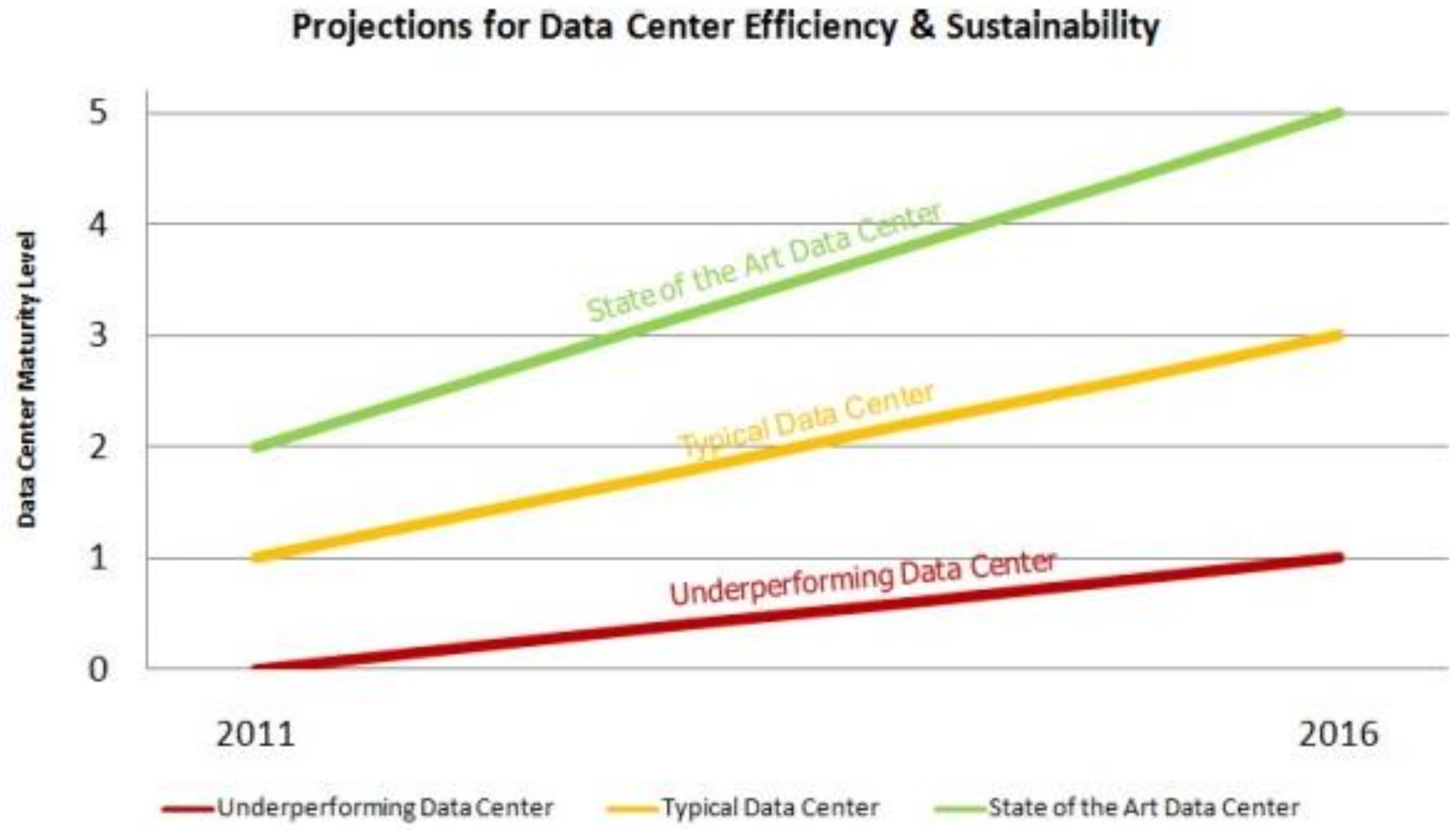
Data Center Stats 2011- 2016



Keep In Mind

When developing a data center, keep in mind the elements that will help efficiency:

- Hot/Cool aisles
- Uninhibited air flow
- How air is being distributed (duct work; directly via the rack)
- Can you take advantage of the climate of the region? (Drawing on the cold air of cooler climates)

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QUESTIONS?

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Mark Wutz, PE, CEM, LEED AP, CPMP

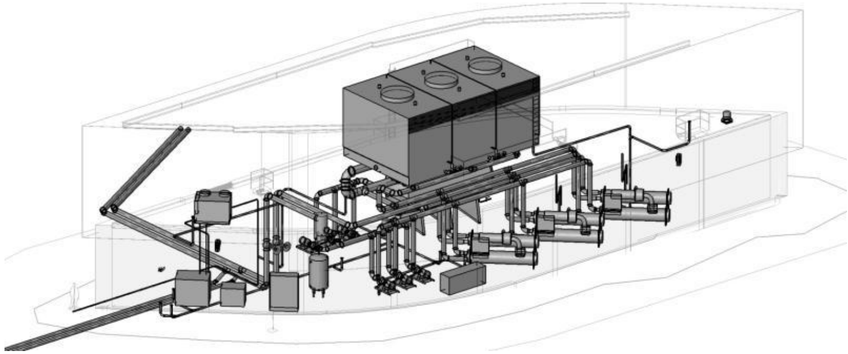
Director of Energy Management, URS Corporation

- Bowling Green State University HB251 Energy Conservation Master Plan
- Kent State University HB251 Energy Conservation Master Plan
- Southern Methodist University Energy Assessment
- Wright State University HB251 Energy Conservation Master Plan
- Cleveland State University HB251 Energy Conservation master Plan
- University of Dayton Energy Assessment
- Cleveland Clinic Energy & Sustainability Design Standards
- Kraft Foods Energy & Infrastructure Assessments
- Johnson & Johnson Developed LEED “Cookbook”
- Procter & Gamble Process Energy Analysis & LEED Consulting
- Cuyahoga County Municipal Energy Program
- Jones Day Data Center Infrastructure Upgrades
- IRS Enterprise Computing Center Commissioning
- BGSU Hayes Hall Data Center HVAC Replacement
- Network Warfare Center LEED Energy Modeling

Energy Management

Services:

- Demand side management
- Supply side management
- LEED Consulting
- Energy Star Portfolio Manager
- Greenhouse Gas Inventory
- Full A/E Design / Implementation Assistance
- Construction / Program Management
- Commissioning
- Retro-Commissioning
- Measurement & Verification
- Grants / Utility Incentives / Tax Credits



ENERGY STAR

Energy Management

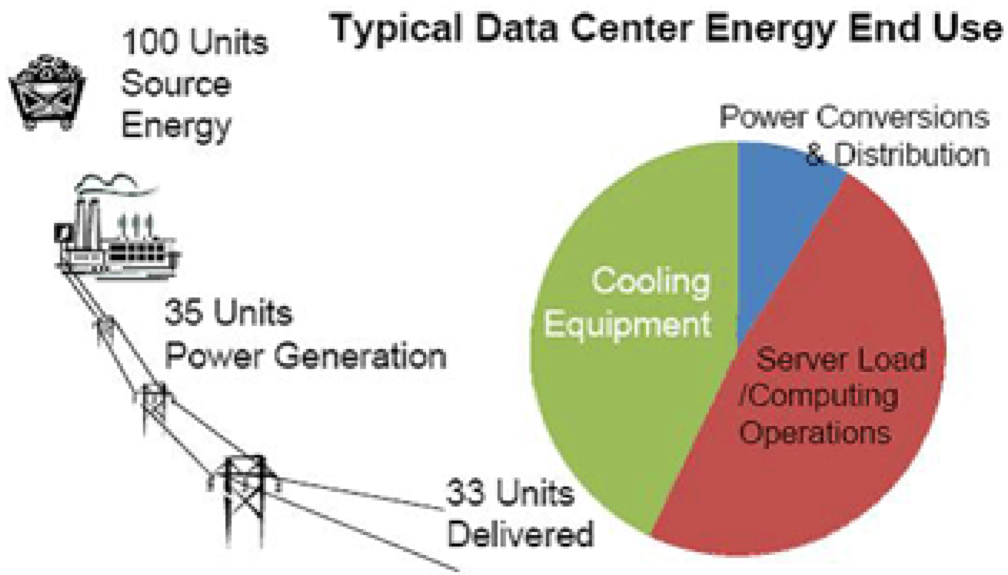
"Energy Management is the process for the monitoring, control and conservation of energy and is a key element of sustainability"

Benefits:

- Reduced operating and maintenance cost
- Improved air quality
- Improved environmental conditions
- Address deferred maintenance
- Reduced demands on existing infrastructure and reduce capital cost to increase capacity
- Improved safety & reliability
- Process improvement by increasing production or reducing waste
- Regulatory compliance

Background

- 1.5% of electricity ($4.5 billion) is consumed by Data Centers, growing at 12% per year – doubling every 5 years
- 2000 Data center energy consumption was 30 billion kWh
- 2006 Data center energy consumption was 60 billion kWh
- 2011 Data center energy consumption is expected to be 120 billion kWh
- Server utilization is often less than 6 percent
- Facility utilization is often less than 50 percent.
- Typical PUE is 2.0; Efficient Data Centers can have a PUE of 1.2



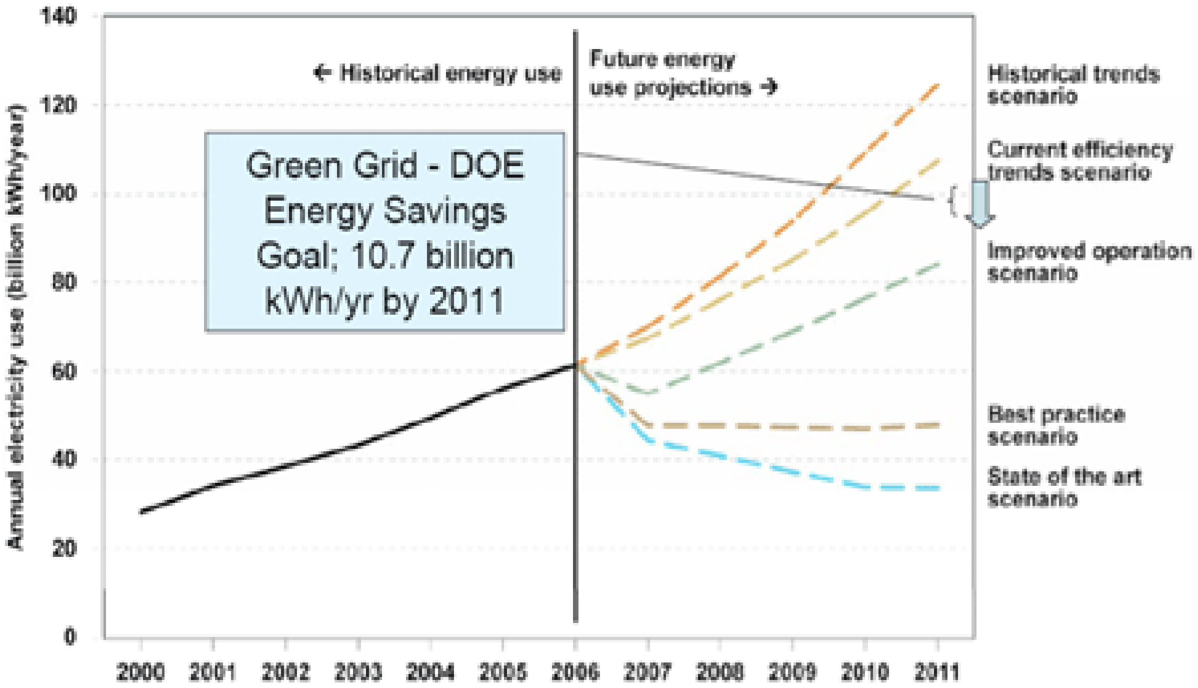
Power Usage Effectiveness (PUE)

$$\mathrm{PUE} = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

Challenges

- Cooling demand is fairly constant, thereby reducing the potential benefit of variable flow and/or staging of equipment
- Raised floors typically contain cabling that impedes air flow
- Raised floor & envelope leaks can reduce effectiveness and efficiency of cooling
- Converting existing facilities to hot aisle / cold aisle configuration
- Re-entrainment of heat from servers and cold air bypass of server intakes
- Space humidity requirements can make air side economizing non-viable
- Year round cooling can make it impractical to connect to a large more efficient central chilled water plant
- Maintaining N+1 redundancy while adding servers
- Power, cooling and space constraints in existing facilities
- Cost and downtime required to optimize efficiency
- Meeting and exceeding LEED Minimum Energy Efficiency Prerequisite
- Financial & operational responsibility is often held by different departments
- Decisions are often made without sufficient consideration of upstream and downstream impacts

Opportunities



Electrical Infrastructure → IT Infrastructure → Airflow Management → Computer Room Air Handlers → Central Plant → Humidification → Lighting → Commissioning

Opportunities

Electrical Infrastructure. Protection from power loss is a common characteristic of datacenter facilities. Such protection comes at a significant first cost price, and also carries a continuous power usage cost that can be reduced through careful design and selection.

- High efficiency transformers
- Optimize UPS Efficiency
  - Specify Minimum Unit Efficiency at Expected Load Points
  - Evaluate UPS Technologies for Most Efficient
  - Do Not Overspecify Power Conditioning Requirements
  - ***Remove redundant rack mounted UPS***
  - ***Operate UPS in switched bypass mode***
- Use Self-Generation for Larger Installations
  - Trigeneration
  - Eliminate Standby Generators

Opportunities

IT Infrastructure. The IT equipment is the reason for the facility. Increasingly, there are reasonable opportunities to increase the efficiency of IT equipment, reducing the need for mechanical infrastructure and ongoing energy use directly at the load level through the selection of IT equipment.

- ***Specify Efficient Server Equipment***
  - ***Specify High Efficiency Power Supplies***
  - ***Consider Equipment Power Consumption in Specifications***
  - ***Incentivize Purchase of Efficient Infrastructure***
- Use Cooled Equipment Racks
  - Use Equipment Racks with Integral Coil
  - Consider Direct Liquid Cooling
- Reduce Demand including Downstream Equipment
  - ***Decommission legacy equipment***
  - Data Center Consolidation
  - ***Computer power management / Energy star labeled equipment***
  - Utilize More Efficient Telephone Infrastructure

Best Practices

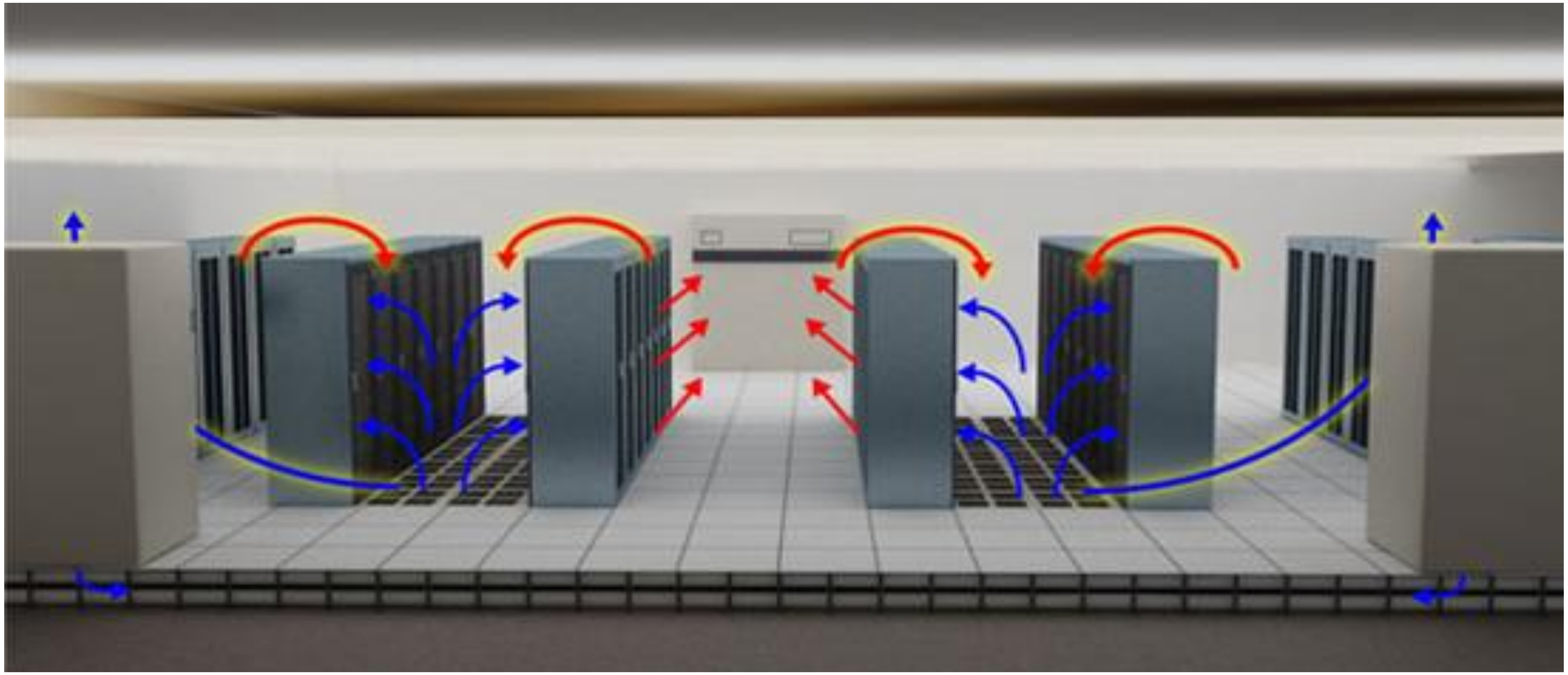
Airflow Management. The efficiency and effectiveness of a datacenter conditioning system is heavily influenced by the path, temperature and quantity of cooling air delivered to the IT equipment and waste hot air removed from the equipment.

- Eliminate Mixing and Recirculation of Hot Equipment Exhaust Air
  - Optimize Hot Aisle/Cold Aisle Layout
  - ***Blank off area above server racks & utilize ceiling plenum for return air in lieu of the room itself to minimize potential for re-entrainment of server heat***
  - Arrange equipment with side to side or top to bottom airflow configurations so they discharge heat away from other server intakes
  - Select Racks with Good Internal Airflow
  - ***Seal raised floor and optimize perforated tile locations***
  - ***Relocate cable from floor plenum to exposed overhead cable trays and remove abandoned cable in order to improve air flow in raised floors.***

Best Practices

Airflow Management (cont'd).

- Maximize Return Air Temperature by Supplying Air Directly to the Loads
  - ***Position Supply and Returns to Minimize Mixing and Short Circuiting***
  - Optimize Location of Computer Room Air Conditioners
  - Provide Adequately Sized Supply & Return Ducts and/or Plenums
  - ***Use an Appropriate Pressure in Underfloor Supply Plenums***



Best Practices

Computer Room Air Handlers. The air handler fan is typically the second largest energy use in the mechanical system, and can exceed the energy use of the cooling plant in some cases.

- Minimize Fan Power Requirements
  - Low Pressure Drop System Design
  - Use Redundant Air Handler Capacity in Normal Operation
- Use an Optimized Airside Economizer
  - Implement an Airside Economizer
  - Design for Medium Temperature Air
  - Control to Avoid Unnecessary Humidity Loads
- Use Large Centralized Air Handlers
  - Use Load Diversity to Minimize Fan Power Use
  - Optimize Air Handler for Fan Efficiency and Low Pressure Drop
  - Configure Redundancy to Reduce Fan Power Use in Normal Operation
  - Use Premium Efficiency Motors and Fans
  - ***Control Volume by Variable Speed Drive on Fans Based on Space Temperature***

Best Practices

Humidification. Humidification specifications and systems are often been excessive and/or wasteful in data center facilities. A site specific design approach to these energy-intensive systems is usually needed to avoid energy waste.

- Design System to Actual Equipment Requirements
  - ***Use Widest Suitable Humidity Control Band***
  - ***Specify Humidity Sensor Calibration Schedule***
  - Provide Appropriate Sensor Redundancy
  - Control Humidity with Dedicated Outdoor Air Unit
- Eliminate Over Humidification and/or Dehumidification
  - ***Ensure Proper Economizer Lockout***
  - Maintain Coil Temperature Above 55F
  - Centralize Humidity Control
- Use Efficient Humidification Technology
  - Use Waste Return Air Heat to Humidify
  - ***Use Adiabatic Humidifiers for Humidity and Evaporative Cooling***
  - Use Lower Power Humidification Technology

Opportunities

Central Plant. When a chilled water plant is used, all the standard design best practices apply, with a few additions. The unusual nature of a datacenter load, which is mostly independent of outside air temperature and solar loads, makes free cooling very attractive and increases the importance of efficiency over first cost. Also, the typical level of redundancy and reliability can influence the value of various design options.

- Maximize the Chiller System Efficiency
  - Select Chiller for High Efficiency
  - Implement an Aggressive Condenser Water Reset
  - Minimize Tower Fan Power and Size Towers for Close Approach
  - Use Free Cooling / Waterside Economization
  - Use a Medium Temperature Chilled Water Loop
  - Use Primary Only Variable Flow Chilled Water Pumping
  - Consider Thermal Storage
  - Monitor System Efficiency
  - ***Recover Heat Rejected by Servers for Building Heating and/or Domestic Hot Water***

Opportunities

Lighting. Datacenters are typically lightly occupied. While lighting is a small portion of the total power usage of a datacenter, it can be often be safely reduced through mature, inexpensive technologies and designs.

- ***Use Active Sensors to Shutoff Lights When Datacenter is Unoccupied***
  - ***Occupancy Sensors***
- Design Light Circuiting and Switching to Allow for Greater Manual Control
  - Bi-Level Lighting
  - Task Lighting
- ***Utilize more efficient lighting***
  - ***De-lamp where over-illumination exists***
  - ***Retrofit T12 linear fluorescents with T8***
  - ***Replace HID and incandescent downlights and exit signs with compact fluorescent or LED***

Opportunities

Commissioning. An efficient data center not only requires a reliable and efficient design, it also requires proper construction and operation of the space. Commissioning is a methodical and thorough process to ensure the systems are installed and operating correctly in all aspects, including efficiency.

- Perform System Commissioning
  - Peer Review
  - Document Testing Procedures for All Equipment incorporating Control Sequences
  - Measure Equipment Energy Efficiency Onsite
  - Functionally Test Equipment
- ***Perform Retrocommissioning***
  - ***Perform Energy Assessment***
  - ***Thermal Imaging***
  - ***Benchmark Current Operation and Energy Consumption***
  - ***Functionally Test Equipment and Recalibrate Sensors***
  - ***Ensure Best Maintenance Practices are Utilized & Ensure Staff is Properly Trained***
  - ***Install Efficiency Monitoring Equipment***

Energy Management - *Process*

DATA COLLECTION
- Utility Bills
- Drawings
- Capital Plan
- Past Studies

SITE SURVEY
- Interview & Engage Maint Staff
- Observe & Document
  - ✓ Operation
  - ✓ Space Utilization
- Obtain Nameplate Data
- Field Verify Drawings

ANALYSIS
- Utility Bill Tabulation & Analysis
- Identify Deficiencies & ECM's
- Identify Synergies
- Develop Baseline Energy Model
- Calculate Energy Savings
- Develop ROM Cost Estimates

VALIDATION
- Field Verification
- Re-interview Maintenance Staff
- Take Measurements
- Calibrate Baseline Energy Model
- Refine Energy Savings Calcs

JUSTIFICATION
- Develop Detailed Cost Estimates
- LCCA, ROI & Cashflow Analysis
- Identify Synergies

PROJECT DEVELOPMENT
- Prioritize / Develop Timeline
- Coordinate with other Projects
- Identify Funding Opportunities
  - ✓ Grants
  - ✓ Utility Incentives

IMPLEMENTATION
- Traditional: Design-Bid-Build
- ESPC: Program Management
- Commissioning
- Training

MEASURE & VERIFY
- Utility Metering
- Actual vs Modeled Energy
- Calibrate Energy Model
- Develop CAP / Future ECM's

Feedback

Ensure that energy studies and condition assessments become actual projects with results that are measured and verified in order to ensure long term success

Energy Management

“***Making the Business Case***”:

- Detailed, accurate cost estimates
- Life Cycle Cost Analysis, Return on Investment and Cashflow Analysis
- Integrated Programs that Leverage Synergies with Concurrent Projects, Capital and Master Plans.

KENT STATE UNIVERSITY

Kent State University
Energy Conservation Master Plan

Financial Analysis

Project Cost:	$22,089,571	Total Debt Service Cost	($5,382,365)
APR*	4.50%	Total Cumulative Cash Flow:	$20,909,794
Period - Length	10	Simple Payback Period (SPP)	5.74
Utility Inflation	5.00%	% Energy Cost Savings	34.3%
Operational Cost Inflation	3.00%	Return on Investment (ROI)	16.0%
Estimated Energy Savings	$3,846,564	% CO2e Reduction	25.4%

Year	Energy Savings	Operational Savings	Annual Auditing Service Fee	Total Savings	*Annual Program Cost	Cash Flow (Savings-Cost)	Cumulative Cash Flow (Savings-Cost)
INSTALL				($22,089,571)			
1	3,846,564	0	0	3,846,565	-2,747,194	1,099,372	1,099,372
2	4,038,893	0	0	4,038,895	-2,747,194	1,291,701	2,391,073
3	4,240,837	0	0	4,240,840	-2,747,194	1,493,647	3,884,720
4	4,452,879	0	0	4,452,883	-2,747,194	1,705,690	5,590,409
5	4,675,523	0	0	4,675,528	-2,747,194	1,928,335	7,518,744
6	4,909,299	0	0	4,909,305	-2,747,194	2,162,112	9,680,856
7	5,154,764	0	0	5,154,771	-2,747,194	2,407,578	12,088,433
8	5,412,502	0	0	5,412,510	-2,747,194	2,665,317	14,753,750
9	5,683,128	0	0	5,683,137	-2,747,194	2,935,943	17,689,693
10	5,967,284	0	0	5,967,294	-2,747,194	3,220,100	20,909,794
Total	48,381,674	0	0	48,381,729	-27,471,936	20,909,794	

Note:
* Annual payment cost is based on 12 equal monthly payments per year.

Case Study – Kent State University

Computer Power Management

- Enable the hibernate power management feature on all University owned computers to automatically power down the central processing unit and monitor to achieve an overall campus energy reduction of *4.95%*.
- Educate and encourage students to utilize the power management features of their computers to minimize power consumption to achieve an overall campus energy reduction of *1.09%*.
- Require all new computers to be energy star compliant notebooks to achieve an additional overall campus energy reduction of *0.80%*.

Overall annual energy cost savings: $915,964

Technology Infrastructure Upgrades

- Replace 613 existing core data edge devices with 353 Nortel edge devices to achieve an overall campus energy reduction of *0.19%*.

Resources

High Performance Buildings for High-Tech Industries:

http://hightech.lbl.gov/datacenters.html

US DOE EERE Website

http://www1.eere.energy.gov/industry/datacenters/index.html

Uptime Institute

http://uptimeinstitute.org/

Silicon Valley Leadership Group

http://dcee.svlg.org/

Server System Infrastructure (SSI) Initiative

https://ssiforum.org/

Green Grid

http://www.thegreengrid.org/

American Society of Heating Refrigeration & Air Conditioning Engineers (ASHRAE)

http://www.ashrae.org/

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