Improving Data Center Energy Performance

General Services Administration
Office of Federal High-Performance Green Buildings

Information in this PDF is excerpted from the GSA report: "Living in a High-Performance Building:

The Story of EPA's Region 8 Headquarters."
June 20, 2013
The full report and executive summary are available Here.

Let's begin

All cost savings estimates are based on energy costs specific to the Denver, CO area at the time in which the report was written.

Who Should Care?

This course provides easy to use energy conservation strategies for an existing data center.

These Quickly Contribute to:

Achieving significant energy savings

Increasing operational efficiencies

Reducing total facility operating cost

Who Should Care?

Facility Managers

Data Center Managers

Building Engineers

Building Owners

Data centers with old/legacy equipment housed in sub-optimum space.

Building Tenant

What Size/Type of Data Center Are We Talking About?

A 1,500 square foot data center located in an office building

Rack-mounted computer hardware in a hot aisle/cold aisle configuration

A one foot high access floor system

Cooling provided by floor mounted CRAC units

Ventilation air provided by a separate system

Tuning Up Your Existing Data Center

Begin by Working with Your Utility Provider and Management Team on the Following:

How can I improve energy performance?

What actions yield the best Return on Investment (ROI)?

Review your Data Center Energy Strategies:

Existing data centers can be more energy efficient using a variety of strategies

You should develop these strategies and review them annually

Many strategies shown on the next pages are simple and cost effective

These strategies can contribute to a reduction in facility operating costs, improved energy conservation and performance

And then Evaluate these Five Main Operational Areas:

1. IT Equipment Improvements
2. Optimizing Airflow Management
3. Equipment Replacement
4. Cooling System Retrofit
5. Lighting Upgrades

Develop Your Strategy

There Are Three Levels of Strategies:

Level 1

What Can I Accomplish with Little or No Funding?

Level 2

What Can I Accomplish with Funding for Equipment?

Level 3

What Can I Accomplish with Capital Improvement Funding?

Level 1: What Can I Accomplish if I Have Little or No Funding?

Here Are Some Energy Saving Ideas That You Can Explore

IT Environment Improvements

Server Virtualization

Server Consolidation

Optimize Airflow Management

Server Layout and Cooling Needs

Floor Diffuser Locations

Install Separation Curtains

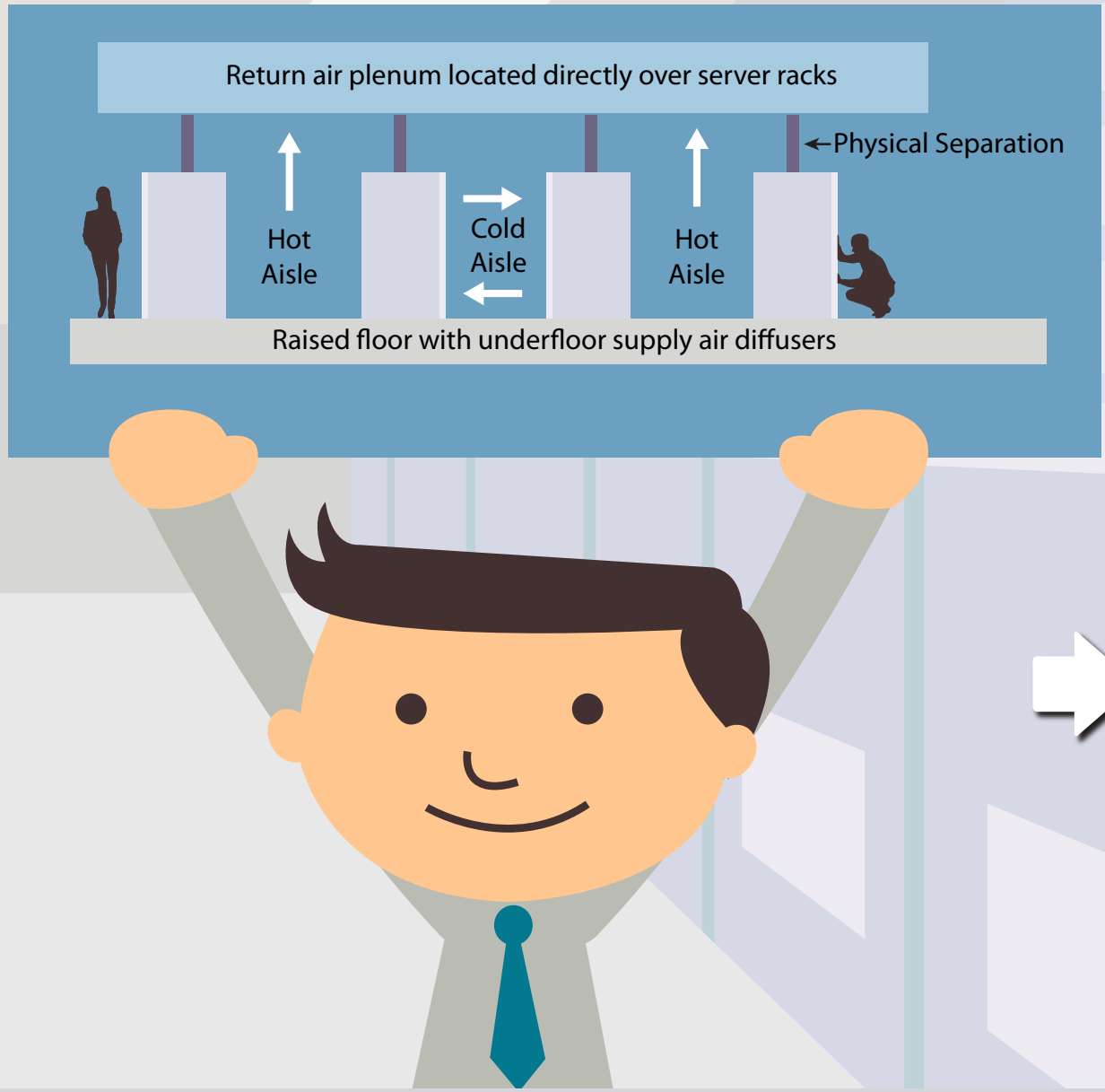
Install Blank Cover Plates in Open Rack Locations

Seal Wall and Floor Openings

Cable Management

Reduce Direct Heat Loads from Lighting

Ventilate Air After Hours



Level 1 Example: Estimated Energy and Cost Savings

Estimated Energy and Cost Savings Using Optimizing Airflow Management Strategies

Energy Conservation Measures	Total Cost (materials and labor)	Energy Savings (kWh/yr)	Cost Savings ($/yr)	Simple Payback (years)
Seal Exposed Openings	$100	-	-	-
Remove Unused Diffusers	$100	-	-	-
Relocate Floor Diffusers	$200	-	-	-
Install Containment Curtains	$5,000	-	-	-
Install Blanks into Racks	$200	-	-	-
Cable Management	$1,000	-	-	
Total	$6,600	32,675	$3,267	2.0

Assumptions:

1) Installed cost for fire rated thermal release data center curtains = estimated $5,000.00
2) Hot/cold aisle containment may reduce the load enough to turn off one CRAC unit
   - Only fan energy is considered as a conservative number.
   - 5 hp motor x 8760 hrs/yr x 0.746 kW/hp = 32,675 kWh/yr
3) Blended electric rate of $0.10 / kWh

Level 2: What Can I Accomplish if I Have Funding for Equipment?

Here Are Some Energy Saving Ideas That You Can Explore:

Computer Room Air Conditioner (CRAC) Unit Upgrade

Replace motors and pumps with high efficiency
– variable speed models

Ventilation System Upgrades

Replace motors and fans with high efficiency
– variable speed models

Modular Uninterruptible Power Supply (UPS) Unit

Replace unit with modular equipment when new batteries are needed. Properly size the UPS unit – more is not better if capacity is underutilized.

Level 2: What Can I Accomplish if I Have Funding for Equipment?

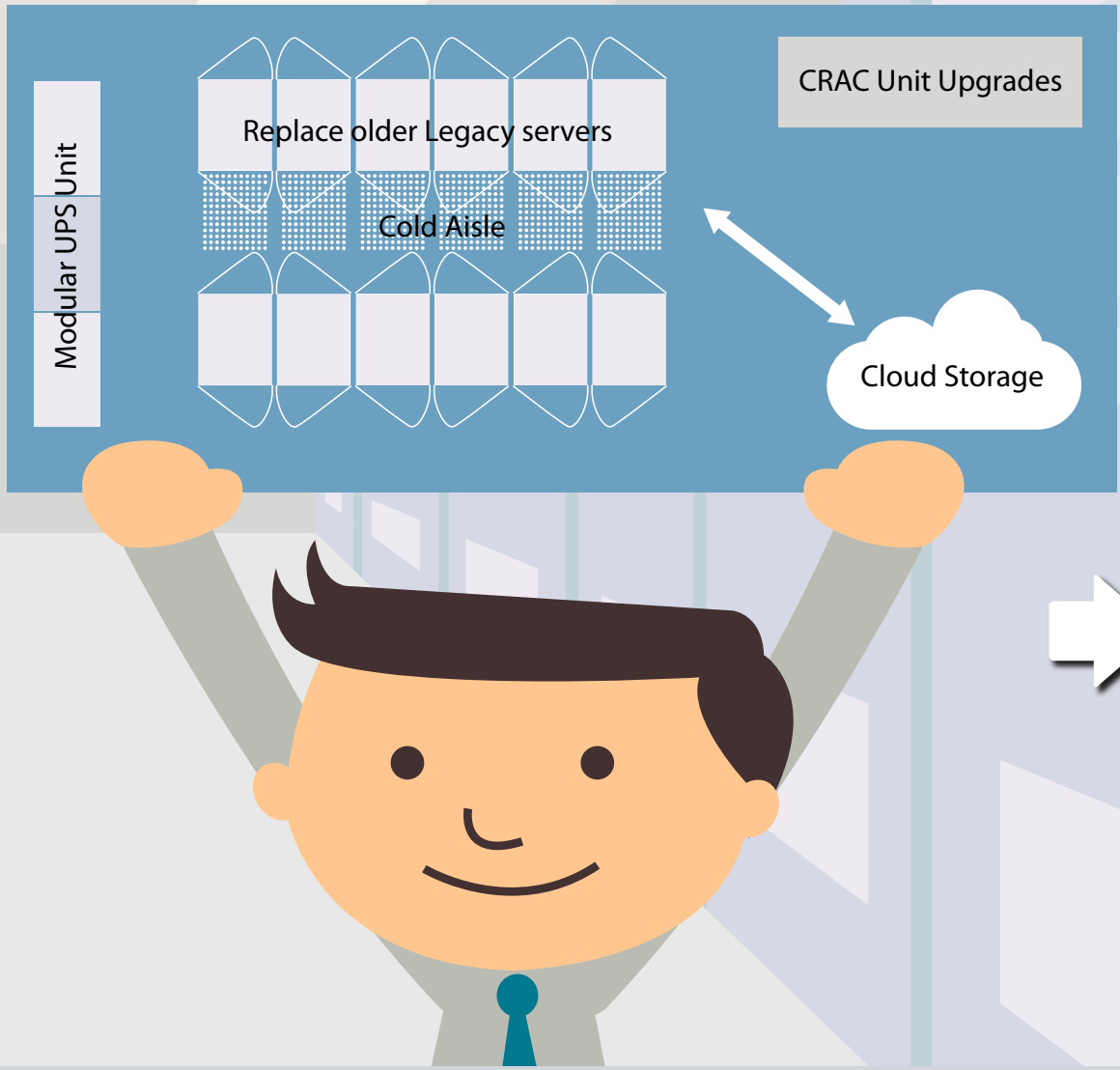
Here Are Some Energy Saving Ideas That You Can Explore:

Legacy Servers

Replace older Legacy servers with new servers that have energy-efficient power supplies and variable speed fans. This can be accomplished through regular technology refresh cycles.

Cloud Storage

Continue efforts to move data to cloud storage reducing the number of servers needed. Virtualization saves money since less hardware is required. A Central Processing Unit (CPU) utilization goal should be set between 60-70%.



Level 2 Example: Estimated Energy and Cost Savings

Estimated Energy and Cost Savings Using Server Upgrades

Energy Conservation Measures	Total Cost (materials and labor)	Energy Savings (kWh/yr)	Cost Savings ($/yr)-	Simple Payback (years)
Replace, Virtualize and Consolidate IT Servers	$150,000	239,148 kWh	$23,915	6.3 yrs

Assumptions:

1) Power Distribution Unit (PDU) utility data showed IT load of 39 kW
2) Assumed a 30% reduction in load, 20 Legacy servers replaced at $5,000 per server
3) Assumed 500 hours of labor for server replacement, virtualization and active consolidation
4) Blended electric rate of $0.10 / kWh

Estimated Energy and Cost Savings Using Modular UPS

Energy Conservation Measures	Total Cost (materials and labor)	Energy Savings (kWh/yr)	Cost Savings ($/yr)-	Simple Payback (years)
Replace UPS with Modular, High Efficiency UPS	$75,000	131,400 kWh	$13,140	5.7 yrs

Assumptions:

1) Replacing the 73% efficient UPS with a 97% efficient unit would reduce losses by 15 kW power distribution unit

Level 3: What Can I Accomplish with Capital Improvement Funding?

Here Are Some Energy Saving Ideas That You Can Explore:

Cooling System Retrofit

A cooling system retrofit can reduce energy use and provide more efficient cooling for the data center

There are two options to consider:

Option A. New Air Handling Unit (AHU)

Install a new AHU for the data center with economizer and direct evaporative cooling

New construction may be required depending on unit size and location

Cold air is supplied into the underfloor air system and discharged in front of the racks by perforated tiles

Option B. Retrofit an Existing AHU

If it is not possible to implement Option A, then the existing AHU could be considered for modification to include an economizer and evaporative cooling. Retrofit elements that might be necessary include:

- Additional variable air volume (VAV) boxes, duct work, and diffusers may be needed to provide the needed cubic feet per minute airflow during unoccupied hours
- During occupied hours, one CRAC unit would still need to operate
- An exhaust duct would need to be installed to relieve the hot aisle air. This would require a pathway to the exterior of the building.

Level 3: What Can I Accomplish with Capital Improvement Funding?

Four Different Cooling Technologies:

These technologies should be evaluated individually and in combination with others to determine the best cooling strategy for your data center.

1. **Direct Expansion.** The most common type of cooling equipment in smaller data centers. These units are usually the least efficient cooling technology for data centers.

2. **Airside Economizer.** Take advantage of favorable outside air conditions, such as nighttime and mild winter conditions. This approach is typically the lowest-cost option.

3. **Direct Evaporative Cooling.** Provides free cooling via a direct evaporative cooling unit. These systems typically will reduce cooling system energy use over a standard air-cooled CRAC unit by as much as 70%.

4. **Multistage Indirect Evaporative Cooling.** High-performance evaporative coolers that surpass standard evaporative cooling performance.

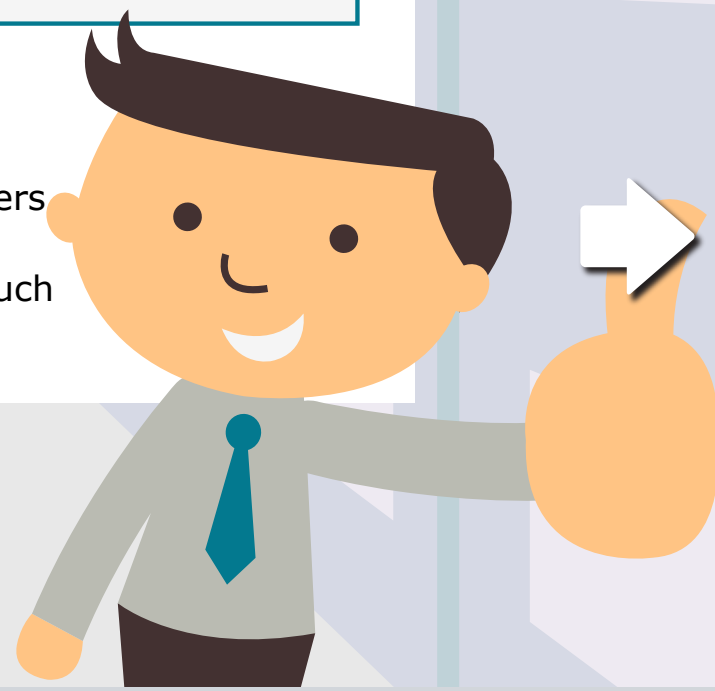
Level 3 Example: Estimated Energy and Cost Savings

Estimated Energy and Cost Savings Using Cooling System Retrofit

Energy Conservation Measures	Total Cost (materials and labor)	Energy Savings (kWh/yr)	Cost Savings ($/yr)	Simple Payback (years)
Option A: Install New AHU with Economizer + Evaporative Cooling	$100,000	555,384 kWh	$55,538	1.8 yrs
Option B: Retrofit Existing AHU to Include Economizer	$50,000	198,000 kWh	$19,800	2.5 yrs

Assumptions:

1) Cost Savings for Option A = 63.4 kW x 8760 hrs/yr x $0.10/kWh
2) Cost Savings for Option B = 33 kW x 6000 hrs/yr x $0.10/kWh
3) Implementation costs were estimated from consultation with mechanical design engineers
4) Does not include water savings
5) On-site staff should investigate implementing a water deduct meter to measure how much water is being evaporated by the cooling towers, to achieve sewer cost savings.



Feedback

In our continued effort to provide you with reliable, accurate information, we would appreciate any feedback or suggestions.

Please view the questions opposite and email any feedback you have to us!

All submissions will be in strict confidence!

Did you find this information valuable?

Do you have plans to upgrade your data center? If so, do you plan to use information in this PDF?

Are there other suggestions or best practices for improving data center energy performance that you would like to share? If so, please tell us about it.

email