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Energy Conservation Measure Recommendations for Cable Edge Facilities

Energy Audits and Analysis of Ten Cable Headends

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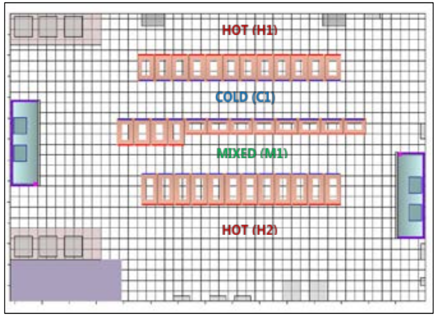
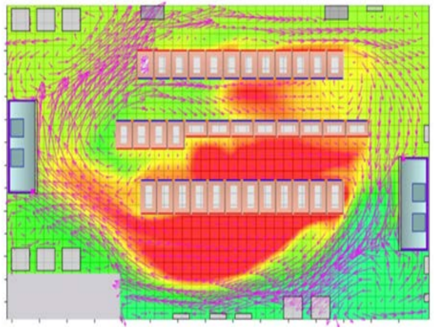
Outline

- Introduction and Executive Summary
- Site Audits and Analysis
- Procedure
- Example Site Assessment: Beaverton, OR
- Portfolio Analysis and Recommendations
- Summary of Savings Resulting from the Recommended HVAC ECMs
- Energy Consumption Trends
- Lighting Opportunities
- Conclusion

10 Comcast headend sites audited and modeled for energy use, airflow management

- Find common problems and issues
- Explore solutions and characterize potential energy savings and other benefits
- ID solutions that apply to most facilities with reasonable payback





Results:

- Identified 3 energy conservation measures that apply to some extent in all facilities
- Total energy savings opportunity for the 10 sites of over $300k per year
- Payback period of about 3 years; lower for sites with higher energy rates
- Many other benefits: increased power margin, eliminate hotspots/alarms true HVAC redundancy, lower CapEx for later HVAC upgrades, and more)

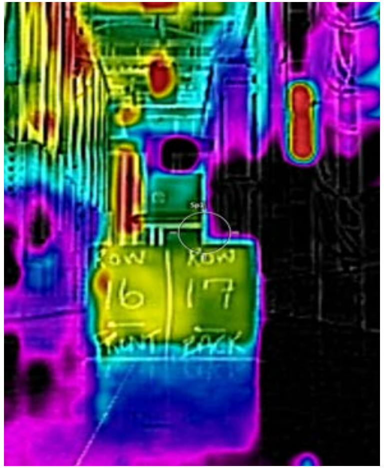
If implemented across footprint, estimated savings exceed $10M / yr

Site Audits and Analysis

Prior to site visit, examined Comcast database, layouts, energy bills, and HVAC data

During site visit, characterized the following:

- Verified/corrected site layouts, rack layouts and IT equipment
- Verified/corrected HVAC specs, condition, and type/amount of refrigerant
- Presence or absence of blanking panels, likewise other aisle containment
- Detailed measurements of HVAC system performance (CFM, temps)
- Thermal images, especially rack inlet hotspots, plus direct temperature measurements
- Floor fans
- Existing sensors and controls
- Discussions with site managers on issues, recent upgrades, and longer term goals



Subsequent analysis explored HVAC optimizations, airflow optimization (via CFD modeling) and potential savings

Common problems and solutions were of key interest

Procedure for Airflow Optimization

A key task is the calibration of the CFD models so they reproduce known issues, hotspots and have enough detail to ensure rack inlet temperatures are maintained or improved

Collect pre-audit data: floor plan, equipment list, available HVAC equipment data

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Site audits: verification and correction of data, measurement of additional parameters and thermal images for calibrating CFD model

↓

Build CFD model and calibrate using site audit data

↓

Explore airflow optimization options and scenarios and select best option for producing energy savings vs. cost of implementation

↓

Determine how high the set point can now be raised and still maintain ASHRAE recommended server inlet temperatures

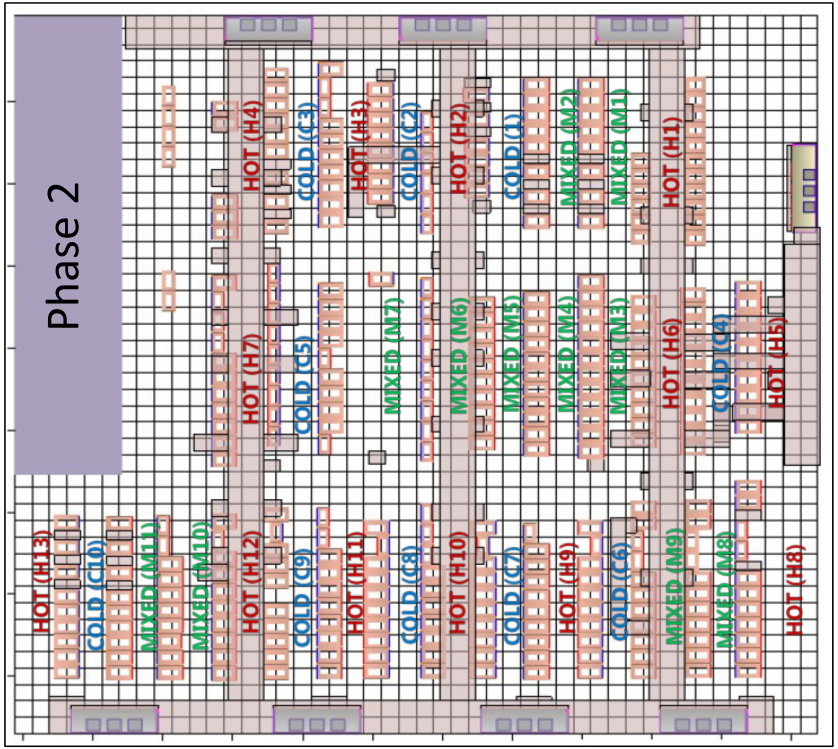
↓

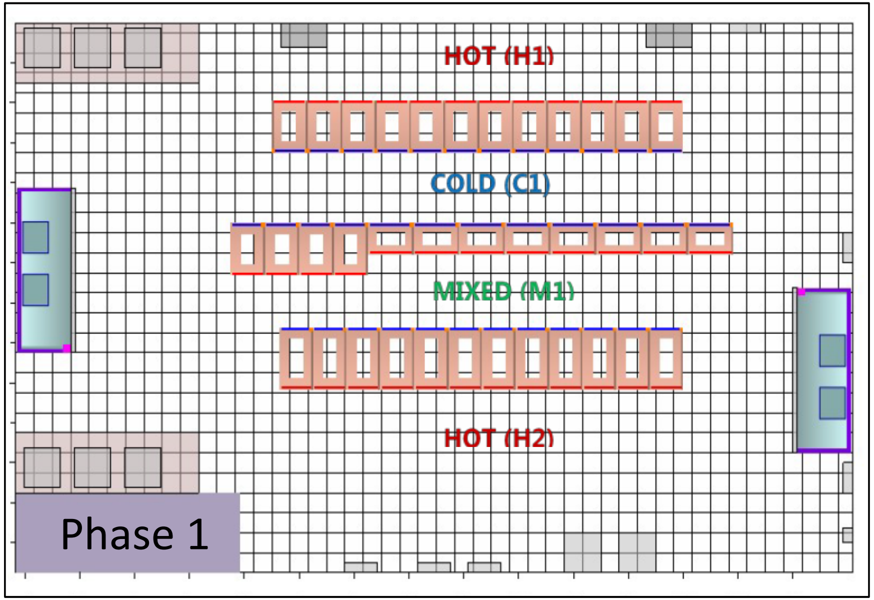
Estimate energy savings from AFO with raised setpoints

CFD modeling can be time consuming, but the right process and right software can make it scalable

Example Site Assessment: Beaverton, OR

Two independent equipment spaces, independently cooled (common in larger facilities)





Note mixed aisles (green) with exhaust from one aisle going into inlets of adjacent aisle

Airflow Modeling with CFD for Phase 1 Headend: Before AFO, After AFO, and Then After Raising Setpoint 6°F

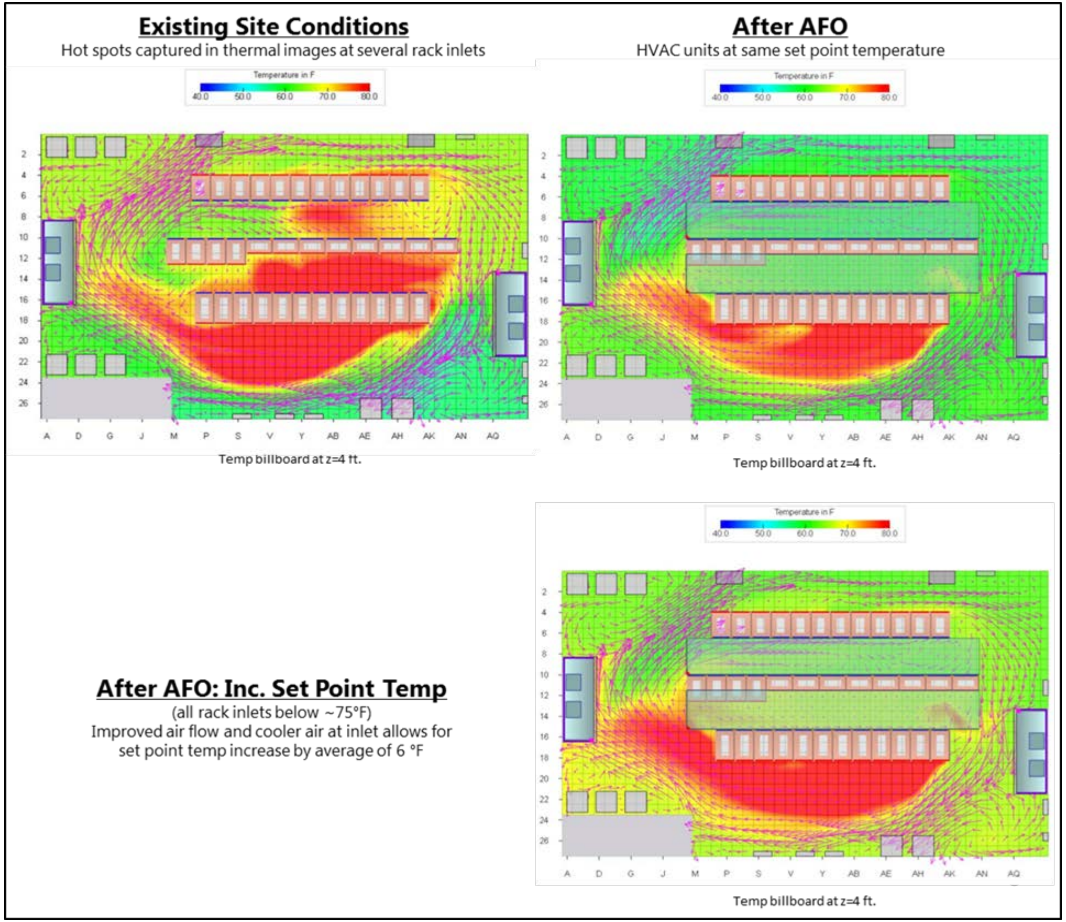
Airflow optimization measures included top & side containment of both the cold aisle and the mixed aisle via adding:

- Blanking panels
- Top rack containment panels

Allowed raising the setpoint by 6 °F

Rack inlet temp improvements:

Range of Max Inlet Temperature	Number of Racks*		
	Base-line	After AFO ECMs	After AFO ECMs and 6°F Set Point Increase
Above 80°F	9	0	0
Between 75°F and 80°F	6	0	0
Between 70°F and 75°F	9	0	7
Below 70°F	6	30	23
Total	30	30	30



Summary of ECM Recommendations for Beaverton, OR Headend

Space	Air Flow Optimization	Advanced HVAC Controls	Refrigerant Replacement
Phase 1 Headend	• Containment: add ceiling panels and blanking panels • ***Raise set point 6 degrees***	• Add HVAC controls to both CRAC units	• Replace refrigerant in both CRAC units
Phase 2 Headend	• Containment: add ceiling panels and blanking panels • ***Raise of set point temperature not recommended***, resulting in no predicted savings from AFO for the site	• Add HVAC controls to all 8 CRAC units	• Replace refrigerant in all 8 CRAC units
Power Room	N/A	• Add HVAC controls to (2) Trane RTU units: RTU-PWR1-2	• Replace refrigerant in (2) Trane RTU units: RTU-PWR1-2
Administrative Areas	N/A	• Add HVAC controls to (2) Trane RTU units: HPU-SR1-2	• Replace refrigerant in (2) Trane RTU units: HPU-SR1-2

AFO improves performance, but may not always lead to savings

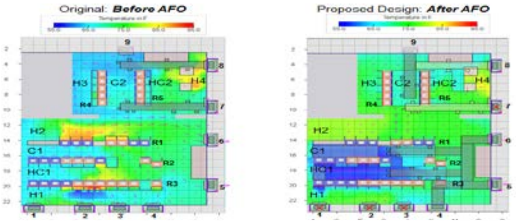
Portfolio Analysis and Recommendations

These issues were found to some extent at all sites:

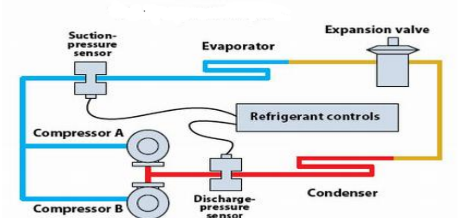
- Mixing of hot/cold air and other airflow management issues
- Absence of blanking panels and incomplete or absent hot-cold aisle configuration
- Presence of R-22 refrigerant
- Lack of intelligent/efficient HVAC controls
- General age issues for HVAC units
- Overstated IT heat loads

Three ECMs would cost-effectively address majority of inefficiency and payback ~ 3 years:

- Customized AFO
- Replace less efficient/ozone-depleting refrigerants
- Add advanced HVAC controls



Airflow Optimization



Nextgen Refrigerant

Advanced Controls

Summary of Savings Resulting from the Recommended HVAC ECMs

Wide range of energy savings available:

- 17-36% HVAC energy reduction
- Average of 22% across portfolio

88 HVAC units with outdated refrigerants

169 HVAC units viable for advanced controls

Implementation cost estimates ranged from $40k - 160k per site

IT heat load over-estimated by 2x on average

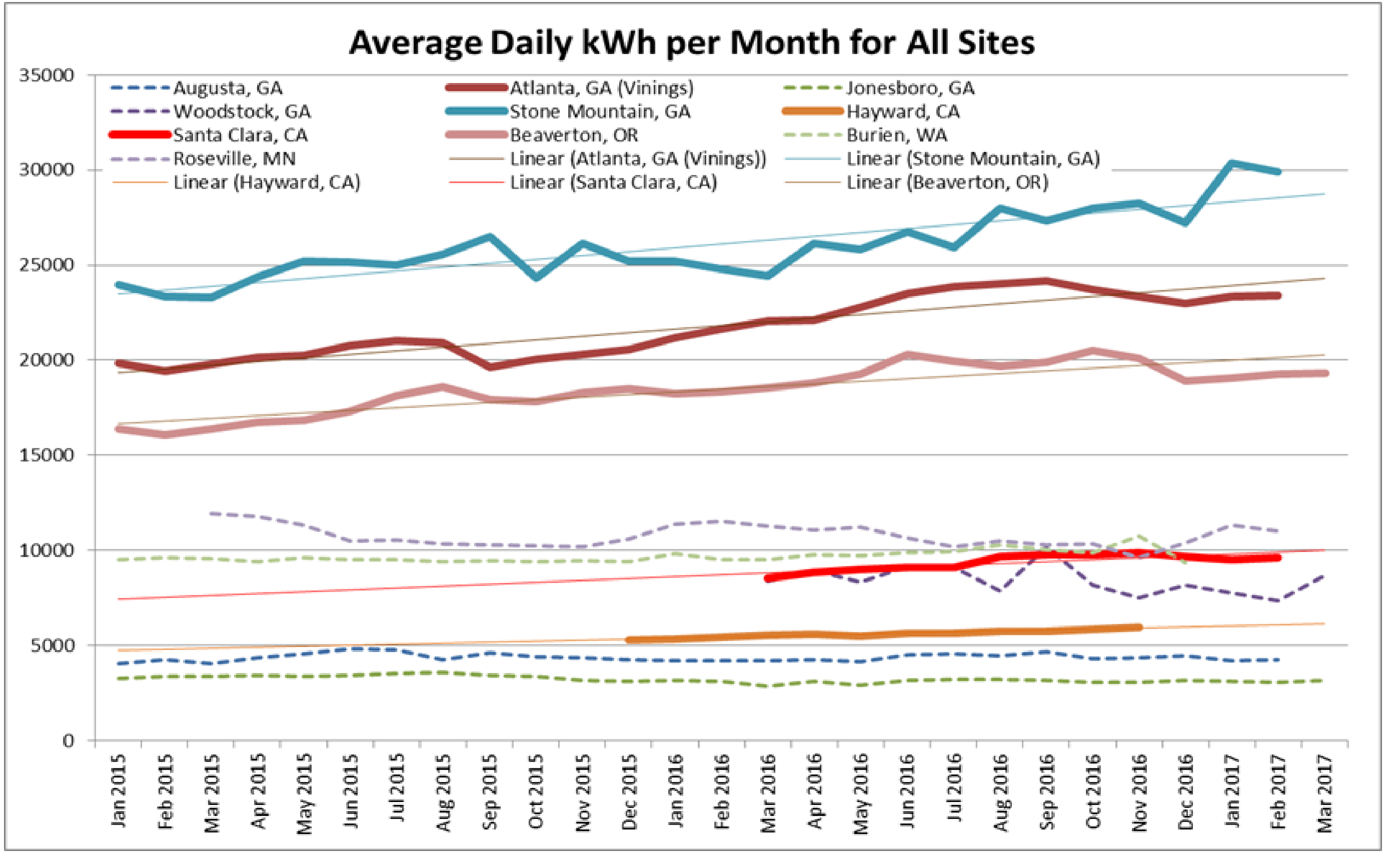
Total 5 yr savings estimated at $1.5M

Facility	Size / Max IT Load	Annual Energy Savings	
		Energy Savings (kWh)	% HVAC Energy Reduction
Roseville MN	24,175 ft^2 / 470 kW	311,133	22%
Hayward CA	33,000 ft^2 / 330 kW	213,206	26%
Santa Clara CA	28,800 ft^2 / 460 kW	284,735	17%
Beaverton OR	13,737 ft^2 / 1,100 kW	479,090	23%
Burien WA	6,561 ft^2 / 530 kW	306,214	19%
Stone Mountain, GA	25,596 ft^2 / 960 kW	704,865	19%
Atlanta, GA	24,626 ft^2 / 1,000 kW	751,019	19%
Jonesboro, GA	6,467 ft^2 / 220 kW	170,482	36%
Woodstock, GA	6,720 ft^2 / 430 kW	384,536	38%
Augusta, GA	10,245 ft^2 / 210 kW	142,933	24%
All Facilities	**179,927 ft^2 / 5,710 kW**	**3,748,213**	**22%**

3 largest sites all had similar growth trends over last 2 yrs

Two smaller sites had greater percentage increase

5 sites had no growth or even slight decrease



While large savings in lighting energy consumption are possible, the relatively low occupancy of most cable edge facilities means it takes longer to payback

Hubs would be even worse for payback on LED lighting

Nonetheless, annual LED lighting savings opportunity for all 10 sites is $60k / year

Facility	Annual Energy Savings	
	Energy Savings (kWh)	% Lighting Energy Reduction
Roseville MN	68,145	76%
Hayward CA	107,265	63%
Santa Clara CA	73,381	71%
Beaverton OR	56,053	76%
Burien WA	29,295	75%
Stone Mountain, GA	137,335	75%
Atlanta, GA	119,977	74%
Jonesboro, GA	36,140	76%
Woodstock, GA	12,079	74%
Augusta, GA	12,947	80%
All Facilities	652,617	72%

LED lighting and controls can still provide savings for edge facilities, but take longer to payback

Conclusion

Even given their diversity, cable edge facilities have good energy savings opportunities

- Look for scalable energy measures that apply to most facilities and scale well
- Look for measures that payback on the order of 3 years
- For airflow optimization, some customization is required, but common issues/trends were seen that enable application with less effort to other sites
- Seek not to impose modern standards at any cost, but rather apply solutions with a keen eye towards payback period and emphasize other benefits of energy conservation measures:

	Meeting New Standards for Facilities	Improving / Maintaining Customer Satisfaction	Lower OpEx Costs		Lower CapEx Costs
			Energy Reduction	Maintenance Reduction	
Airflow Optimization	Move to hot/ cold aisle discipline in all facilities	True HVAC redundancy to prevent IT equipment overloads Reduce alarms and outages	Reduced cooling tonnage / number of HVAC units Eliminates hotspots Permits increasing set point	Fewer HVAC units to maintain	Higher power margin
Advanced Controls	HVAC health check monitoring	Increased visibility of HVAC performance – better able to predict failures and replace accordingly (reduce alarms and outages)	Optimized HVAC runtime Peak demand reduction	Extends HVAC life Reusable on replacement equipment Fewer truck rolls	Higher power margin
Nextgen Refrigerant Replacement	Regulatory compliance for elimination of ozone-depleting refrigerants	PR benefit for Comcast customers who care about the environment	Increased HVAC capacity of existing systems (reducing compressor run time)	Extends HVAC life and reduces load on existing HVAC units	Higher power margin

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THANK YOU!

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