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ENERGY MANAGEMENT AT EDGE FACILITIES

Guidelines for Cable Facility Climate Technology Optimization

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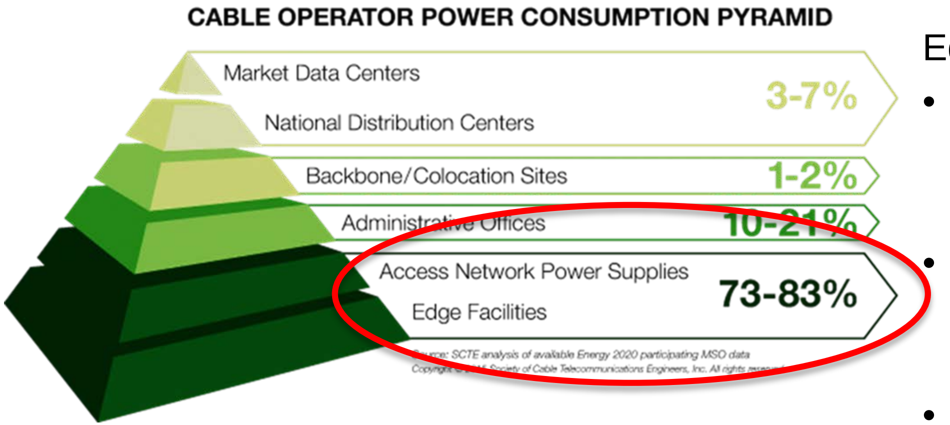
Power at Edge Facilities



Edge Facilities:

- Eclipse MSO Data centers and admin in:
  - Total Number of Sites
  - Total Energy Consumed
- Represent an opportunity to save energy by climate optimization
- Most are older, built or acquired with little attention to cooling design
- Generally mixed cooling, no hot-aisle, cold-aisle and wall mount HVAC with basic control system
- No building envelop factors taken into account

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What Is A Cooling Energy Management Plan?

It is a process with the final goal to:

- ➢ Reduce cost to cool a watt of IT load

How will a plan do this?

- ➢ By identifying changes that improve cooling efficiency
- ➢ Validating the improvement

The plan must:

- Categorize and characterize sites (Edge Facilities)
- Follow a standard methodology
- Clearly define metrics to evaluate solutions and validate them as successful
- Identify areas of concern
- Incorporate all rebates/incentives where available

SCTE 184 Energy Management Operational Practices for Cable Facilities

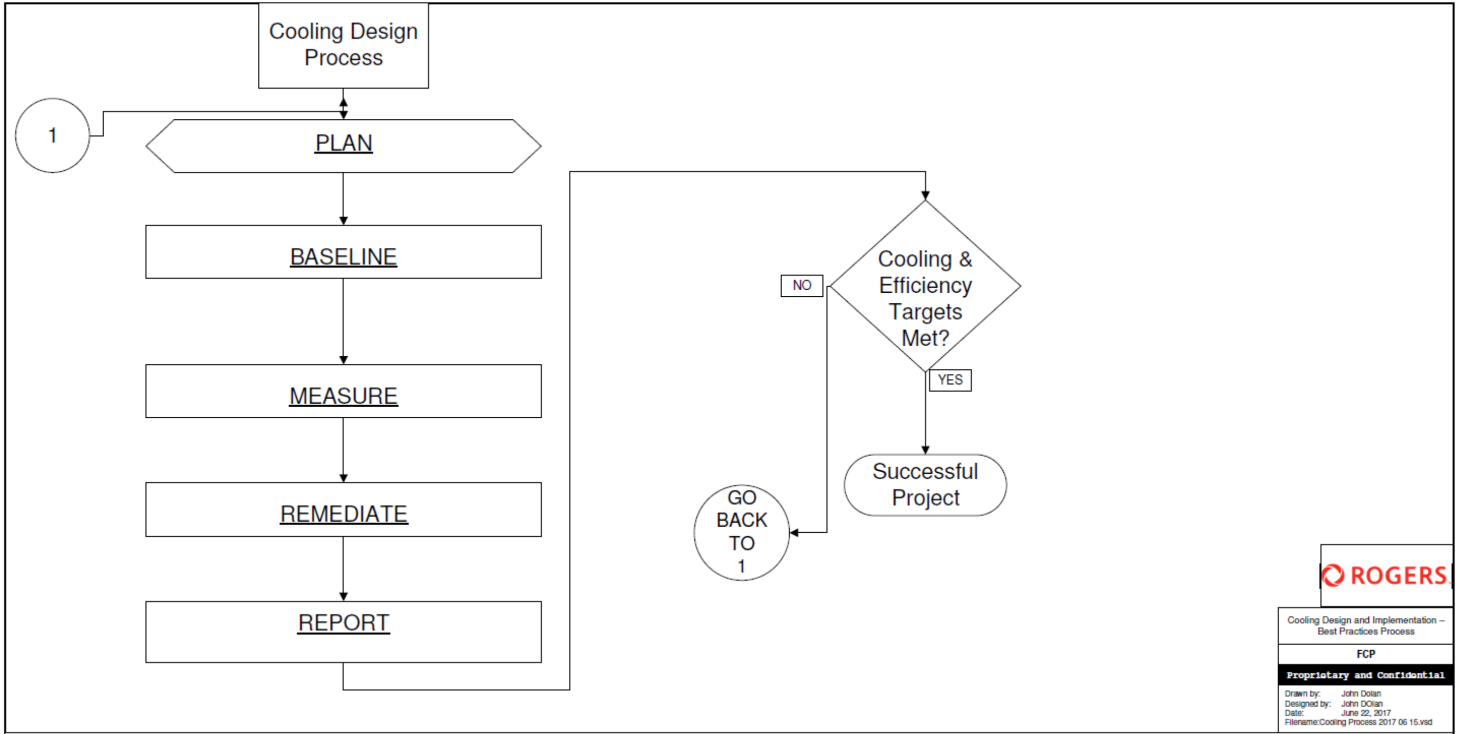
SCTE 213 Edge and Core Facilities Energy Metrics

SCTE 219 Technical Facility Climate Optimization Methodology

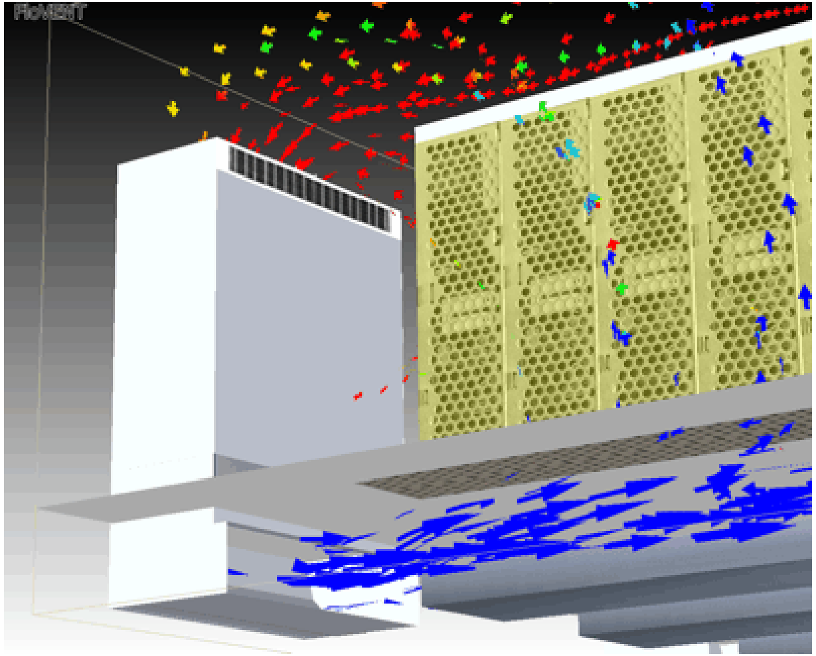
SCTE 226 Cable Facility Classification Definitions and Requirements

Resources

DEVELOP A PROCESS – STANDARD METHODOLOGY



How many in the audience agree that air flow management is the key to cooling efficiency?



Courtesy: Mentor CFD, Robin Bornoff's Blog, September 2014

Agree Scale

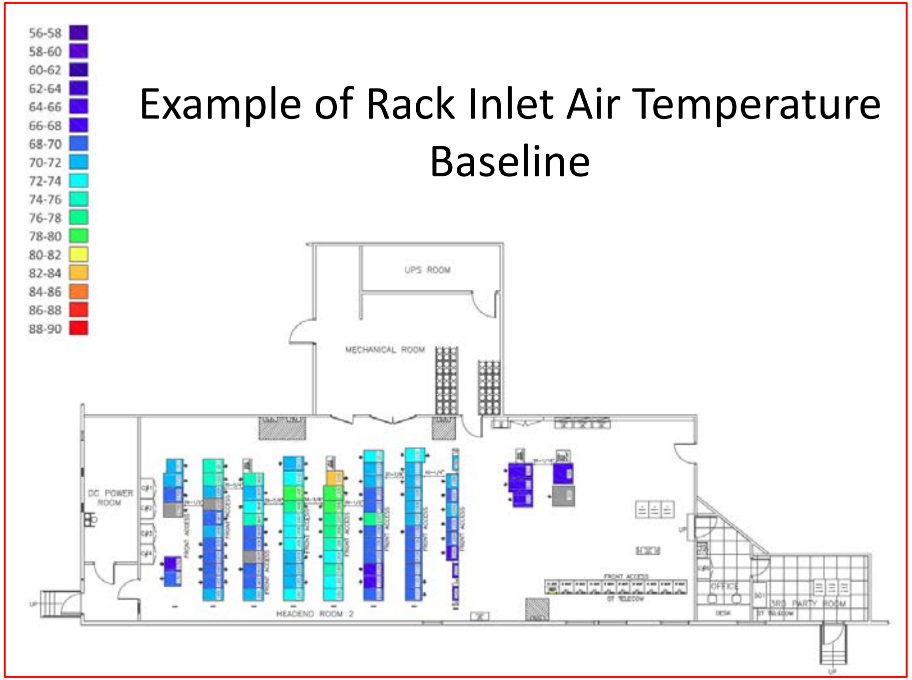
DATA FOR CLIMATE TECHNOLOGY EFFICIENCY

Some data points to measure are:

- Cabinet/rack air inlet temperature
- CRAC supply and return air temperature
- Air flow direction
- Outdoor air temperature
- CFM (cubic feet per minute air flow)
- Air pressure differential
- Humidity

These are useful not only in measuring climate technology efficiency but they are also useful in:

- Reducing alarms
- Reducing hot spots and cold spots
- Reduce temperature variations across the facility
- Improve CRAC redundancy



Example of Rack Inlet Air Temperature Baseline

PLACEMENT AND ORIENTATION OF IT EQUIPMENT GREATLY IMPACTS COOLING EFFICIENCY

Keeping Cold Supply Air separate from Hot Return Air is key.

- Consider/model the cooling impact of new high powered equipment ***before*** it is installed
- Maintain proper setbacks for equipment racks and HVAC units
- Do not block either return or supply air flow with racks and cabling
- Instill hot/cold aisle discipline as new equipment is installed
- Use 100% of existing rack space in lieu of installing a new rack
- Use of blanking panels

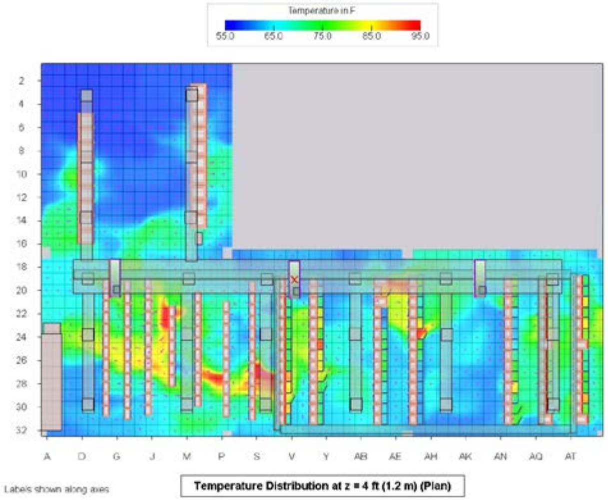
Ideally equipment deployment should be a joint effort between the facilities and IT workforces.

The Facilities workforce should be proactive in recommending new equipment locations.

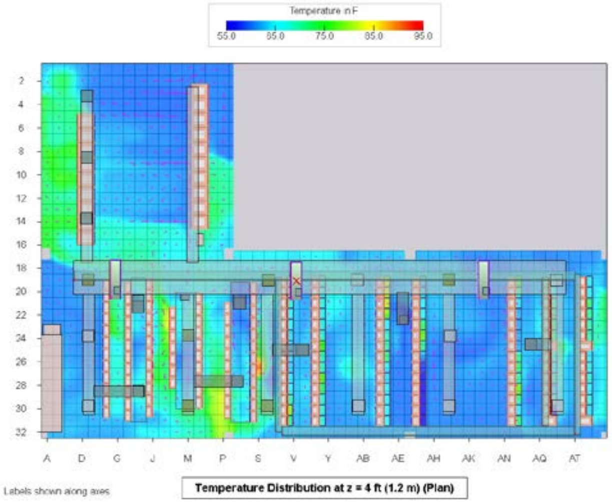
AIRFLOW MANAGEMENT AND DESIGN – BEFORE AND AFTER AIRFLOW OPTIMIZATION AND SET POINT INCREASE

Airflow optimization (AFO) eliminates inlet hotspots enabling raising of HVAC set points to lower cooling costs (Example using CFD – Computational Fluid Dynamics).

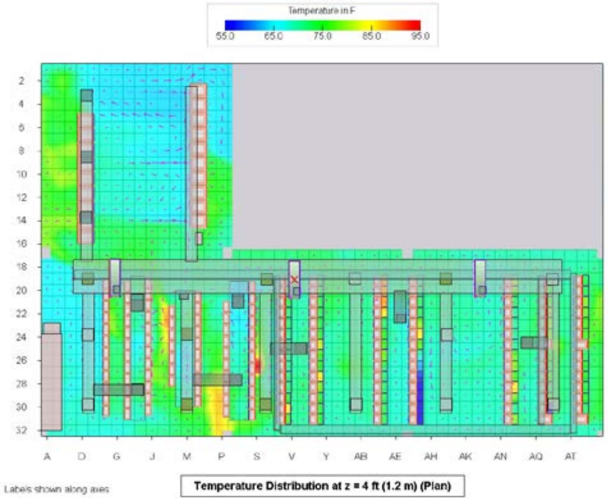
Baseline, before AFO



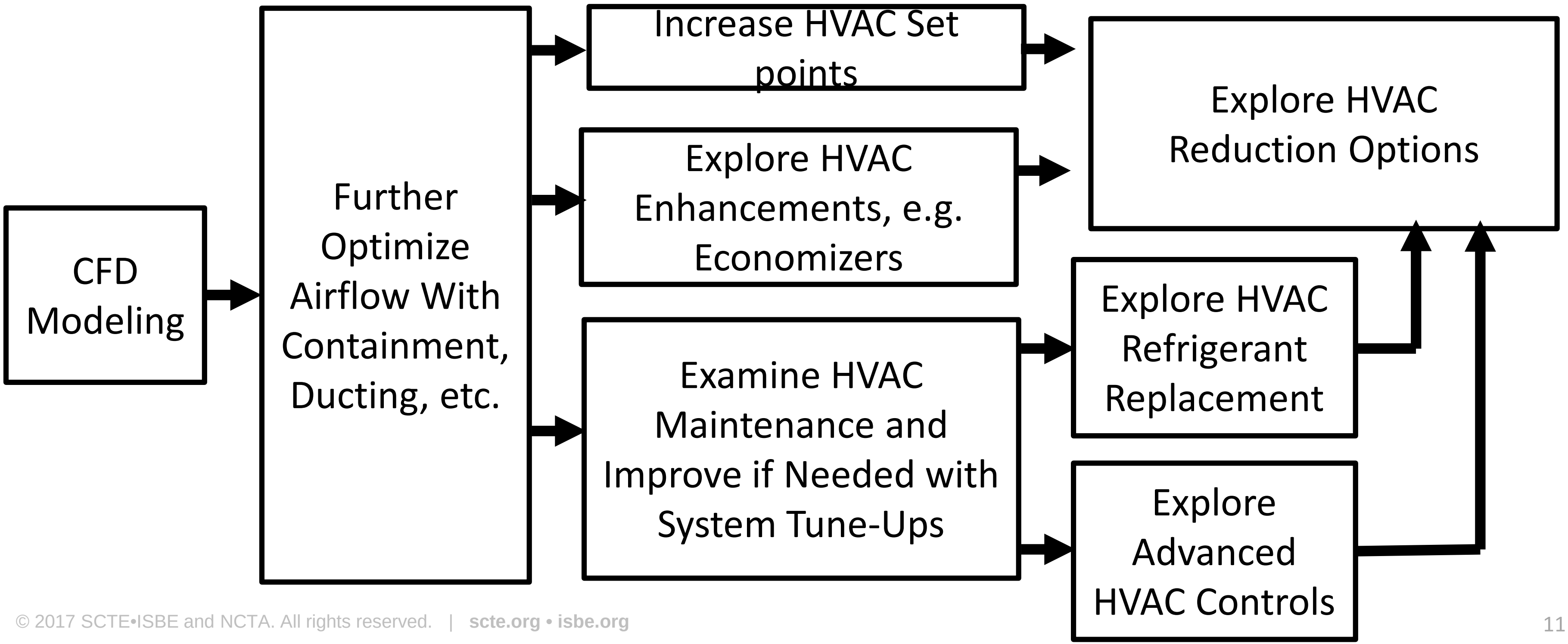
After AFO, hotspots at inlets eliminated



After AFO and after raising set points



BEYOND AIRFLOW OPTIMIZATION



- A study was done by SCTi at a Rogers Facility to determine possible savings by raising the CRAC set point to reduce its energy consumption.
- Expectations in the industry appeared to be modest at 1 – 2% savings.

Results

ROGERS				Energy Reduction		
	Set Point		kW Average	% kW	% kW per	
Data Total for 4 CRAC	°C	°F			°C	°F
2016-10-30 Baseline	21	69.8	93			
10-Dec	25	77	86			
Δ	4	7	7	7.5	1.875	1.042
Per CRAC Annual	kWh		15,330			
	$ at $0.13 per kWh		$2,000			

- Annualized savings: $2,000/CRAC.
- Simple Payback: 1.25 years.
- Assuming 50 similar facilities, savings: $1M.

These type of studies are complicated because of the number of variables.

$$Power\ Usage\ Effectiveness = \frac{Total\ Critical\ Facility\ Energy}{IT\ Equipment\ Energy}$$

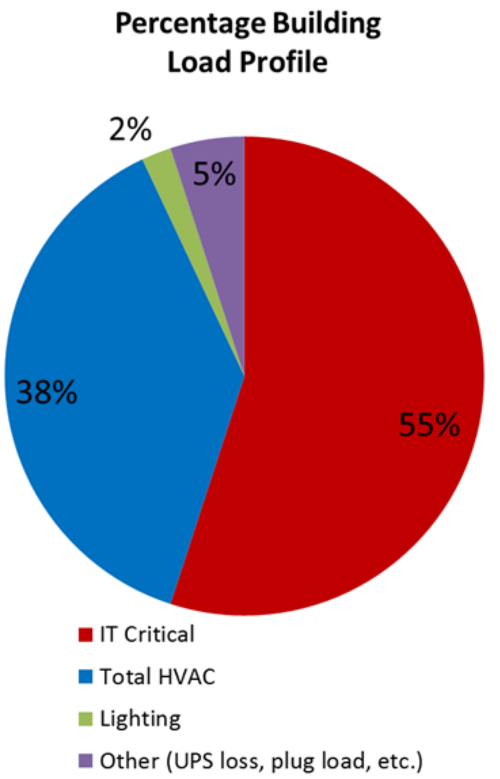
PUE can be estimated, or partially measured. Components of the critical facility PUE reveal individual improvements for energy conservation measures:

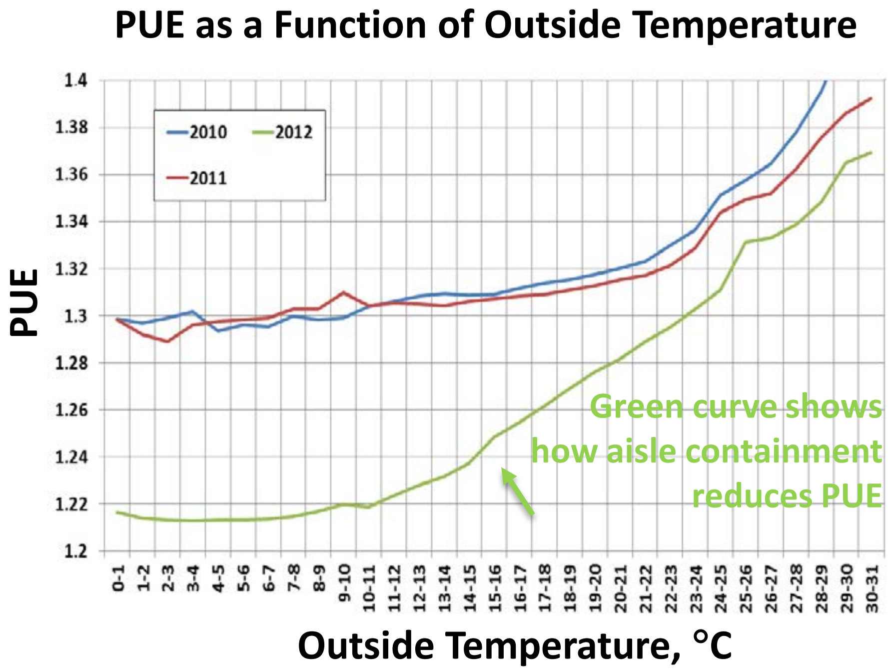
Total Facility Power: $P_{TF} = \boldsymbol{P_{IT}} + \boldsymbol{P_{HVAC}} + PL + PDIST$

$$\mathrm{P_{TF}} * \mathrm{t} = kWh = \$\$$$

Define your PUE and use consistently.

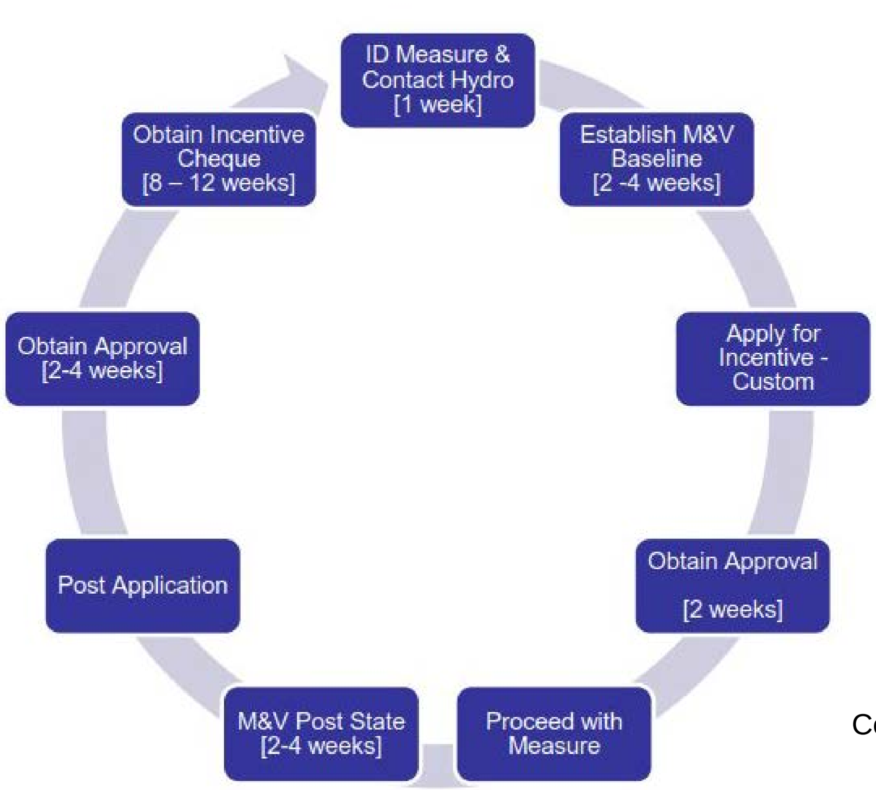
SCTE 213 Edge and Core Facilities Energy Metrics





PUE and associated measurements vary with time, IT load, temperature, but trends can still show benefits of climate technology efficiency improvements

INCENTIVES APPLICATION PROCESS AND TIPS



Courtesy: Toronto Hydro

Energy consumption before and after climate technology optimization must be accurately characterized for internal budgeting and for external purposes such as energy rebates and incentives.

- Pilot any new technologies or approaches in representative and realistic conditions
    - Establish baseline models
        - Gather baseline data – SAT/RAT, SAH/RAH, rack inlet temperatures
        - Install sub-metering on HVAC & IT equipment to measure consumption and PUE
    - Implement energy conservation measures, perhaps staging them to assess each measure independently
    - Gather post-implementation data
    - Calculate energy and cost savings
- Use data to refine goals and design larger programs for entire footprint
- Continue to capture data for ‘health checks’, changing trends, and to explore new opportunities

How Familiar are you with Cooling Technologies Listed Below:

- Direct Expansion (DX)
- Chilled Water (CW)
- Adiabatic Cooling (AD)
- Direct Airside Economizer (DA)
- Indirect Airside Economizer (IDA)
- Pumped Refrigerant (PR)
- Indirect Waterside Economizer (IDW)

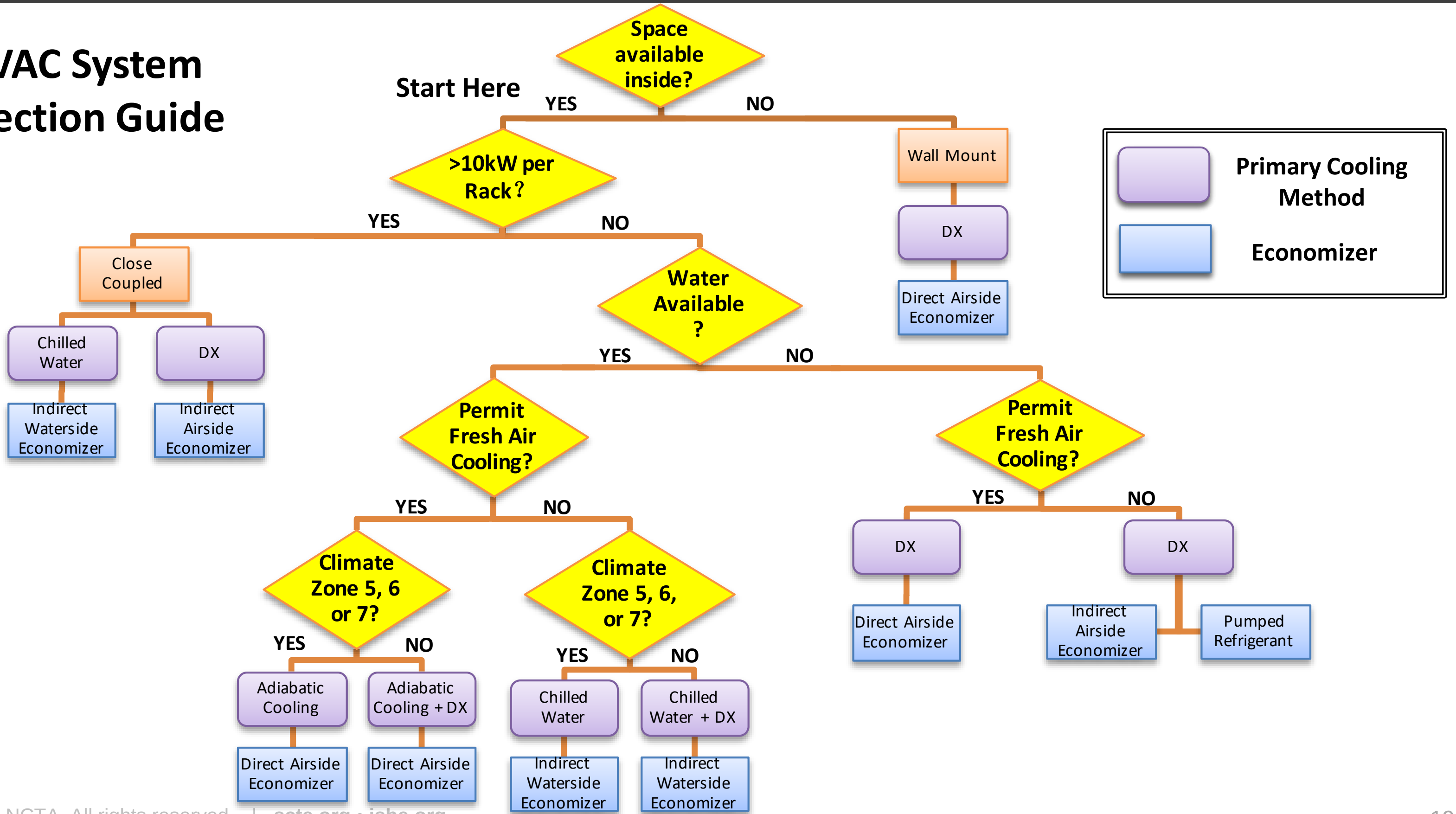
A Familiar with them all

B Familiar with a few

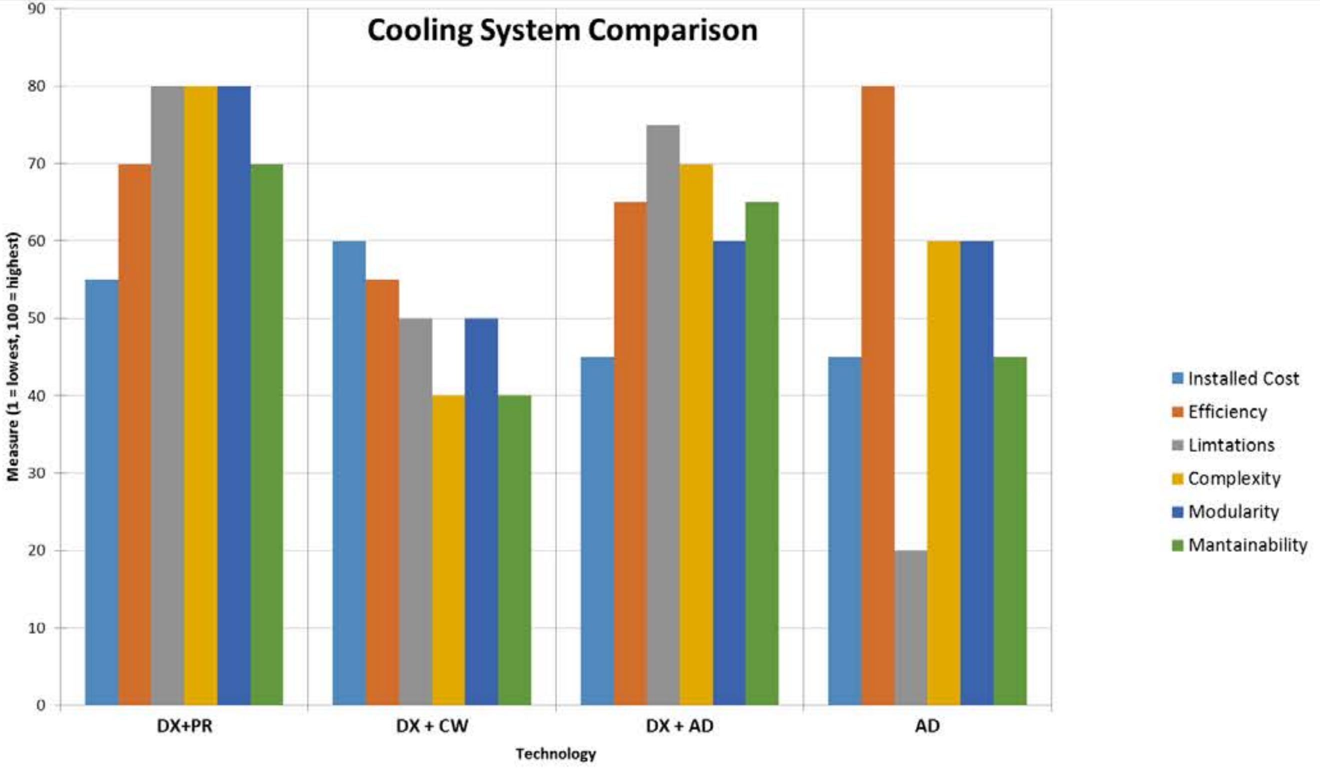
C Doesn’t ring a bell

ABC

HVAC System Selection Guide



COOLING TECHNOLOGY OPTION COMPARISON



Payback

Key point: two ways to look at simple Payback:

1. Financial: Payback period from savings must be less than some number, e.g. 3 years, for climate technology improvements.
2. Non-Financial: Payback period is less important than improvement in customer satisfaction/network uptime. In this case, it is more about increasing reliability, reducing churn, adding more subscribers, etc.

Air Flow is King

- Keeping supply and return air separate has the largest impact on the efficiency of cooling systems.
- Must have an Energy Management Plan to demonstrate efficiencies and savings.
- Establish baselines before a project starts.
- Monitor throughout to have data for comparison at the end of a project to calculate payback.
- Can begin very simply and evolve as required.

Questions?

OPEN-ENDED QUESTION

What one thing would you like to know more about regarding Facility Climate Optimization.

QUESTIONS & CLOSING

If you have further question you can reach me by email

John Dolan: john.dolan@rci.rogers.com

Or feel free to join the SCTE 2020 Subgroup: **Facility Climate Technology Optimization**

Just drop me an email if you want to join.

Meets on line every other Thursday at 2 pm.

Next meeting at: November 2, 2017

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Want to get involved?

The SCTE Standards Working Group on Facility Climate Technology has developed SCTE 219, Technical Facility Climate Optimization Methodology, and is currently developing a comprehensive guidebook that expands significantly on the OP presented here.

Contact me to find out more and get involved!

John Dolan
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THANK YOU!

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Appendix

Datacenter Cooling Product Selection Overview

Primary Options for Cooling: HVAC Equipment

Primary Cooling Options

One or a combination of the method below is typically used as primary cooling method to offset heat load year-round

Direct Expansion (DX)

DX uses a compressor to drive a refrigeration cycle to cool a site. It is also known as mechanical cooling. It introduces no outside air and can cool the indoor temperature cooler than the outdoor temperature. It has the least limitations but is also the least efficient.

Chilled Water (CW)

Chilled water system provides cold water to cool the room. After absorbing heat from the room, the chilled water returns to the chiller where the chiller remotes the heat from the water using the refrigeration process. It has high efficiency but is often quite complex to implement and therefore most often cost effective for very large projects (> 100kW).

Adiabatic Cooling (AD)

Adiabatic cooling works by blowing the supply air through an evaporation pad. Water evaporates as the air passes through the pad, the air cools down much like the process of perspiration cools down your skin. It is very efficient and works best in dryer environments since the cooling capacity is limited when the environment has high relative humidity.

Economization Options

Note: not all economization options are compatible with each primary cooling option.

Direct Airside Economizer (DA)

DA uses fresh air to cool the room when the environmental conditions are favorable. DA is the most energy efficient way of cooling a site because it directly uses the outside air with no loss from heat exchange. In areas with lower air quality, filtration or other mitigating technology must be properly deployed.

Indirect Airside Economizer (IDA)

Indirect airside economizer uses some form of heat exchanger to transfer heat between inside and outside air. It has lower efficiency than direct airside economizer but does not introduce outside air into the room.

Pumped Refrigerant (PR)

Pumped refrigerant economizer uses an economizer pump in place of the compressor when the outside air is significantly colder than the room temperature. Similar to indirect airside economizer, it does not introduce outside air. Additionally, it does not require any large wall penetration but usually has higher upfront cost (equipment and installation).

Indirect Waterside Economizer (IDW)

Indirect waterside economizer typically uses one or more cooling towers and heat exchanger to offload all or parts of the chiller’s load. Freeze protection must be considered for colder regions.

ROI ≡ Return On Investment:

The amount of time it takes for the operational cost savings to add up to the original project spend.

ROI (yrs) = total up front cost/annual operational savings

ROI Calculation **OPTION I**: Equipment *EOL is not factored in

- Total Project Cost = PC
- Operational cost savings: (REC + M&R)
  - Annual Reduction in Electricity Consumption Costs = REC
  - Annual Reduction in Maintenance & Repair Costs = M&R

ROI (yrs) =

$$\frac{(PC)}{(REC + M\&R)}$$

ROI Calculation **OPTION II**: Equipment EOL is factored in. Once decision has been made that equipment has reached End Of Life and therefore Will Be Replaced then ROI decision can be based on:

Lowest Cost approach for replacing EOL equipment **vs Best Achievable Efficiency Cost** for replacing EOL equipment

- Project Cost **Difference** = Best Achievable Efficiency Project Cost – Lowest Cost approach = PCD
- Differential Operational cost savings: (RECD + M&RD)
  - Differential Annual Reduction in Electricity Consumption Costs = RECD
  - Differential Annual Reduction in Maintenance & Repair Costs = M&RD

ROI (yrs) =

$$\frac{(PCD)}{(RECD + M\&RD)}$$

*EOL ≡ The point in time when cost of annual repair is projected to be ~ 50% of the cost of replacement equipment

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