QUEST

QUANTUM ENERGY SERVICES & TECHNOLOGIES, INC.

Data Center Optimization

Review of Current Program Results

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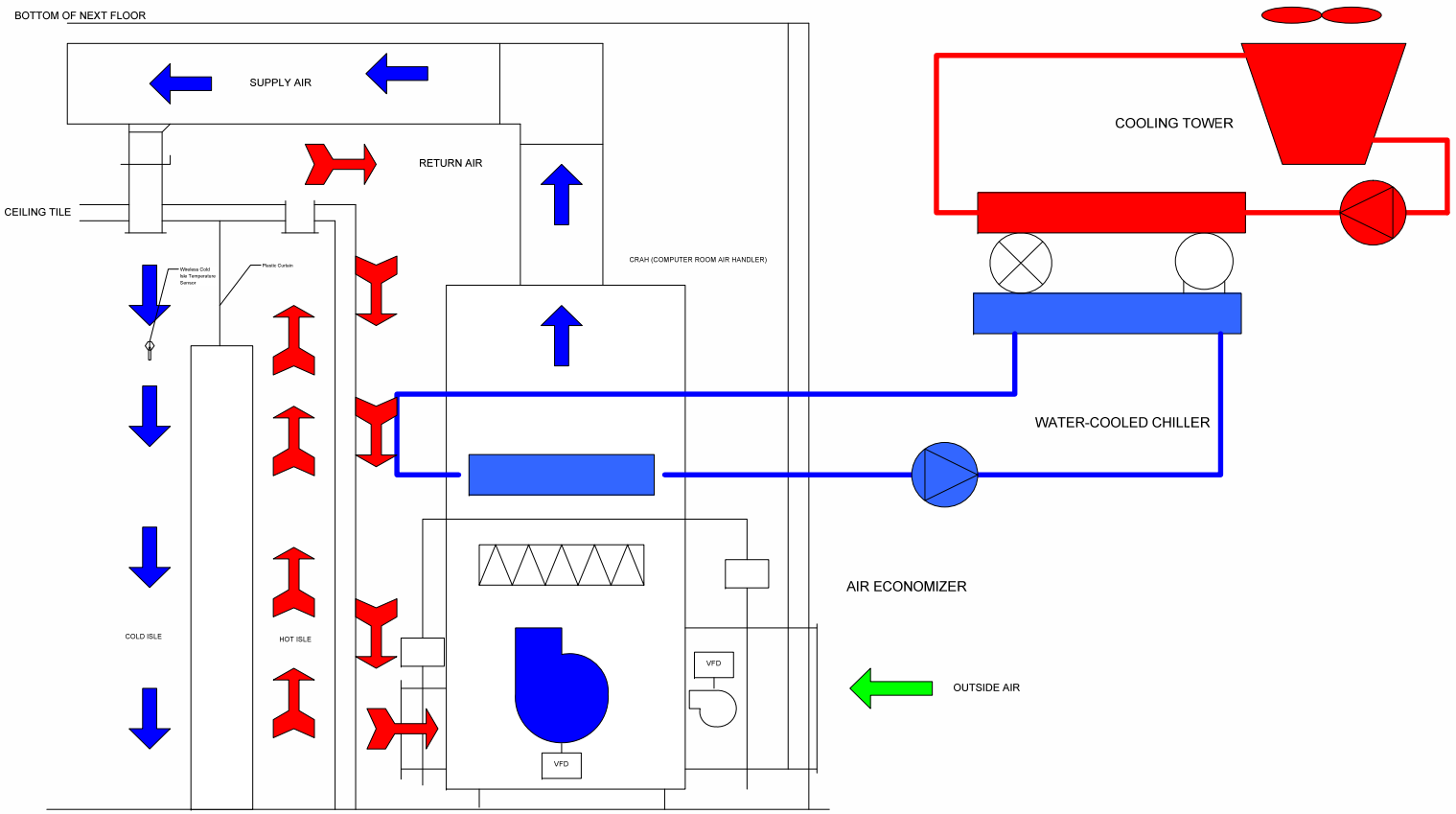
Objective: Demonstrate the value of measuring and verifying the savings associated with a Data Center retro-commissioning project.

- Execution of the NA DC B-11, a relative efficient data center, demonstrates that optimization levels of a traditional HVAC cooling system have not been defined yet.
  - The pre-installation characteristics indicated that the data center was efficient.
  - The cold aisle temperatures were higher than 68 deg F.
  - The air temperature differential between supply and return air was at design (20 degrees).

NA B-11 Data Center HVAC Optimization Project Scope of Work

- Install an array of wireless sensors in cold aisles
- Integrate wireless sensors with EMS to control VFDs
- Install flexible plastic barriers from top of racks to ceiling
- Install block-out plates in empty rack spaces
- Install MA temperature sensors in the MA plenums of each economizer
- Integrate MA temperature sensors with EMS
- Alter control algorithm to allow economizer dampers to optimize the economizer operation



BUILDING 11 DATA CENTER HVAC DIAGRAM

Implementation of measures does not always guarantee savings

- Although fan speed was reduced more than expected, the meter showed no savings
- The measurement of the impact associated with the speed reduction demonstrated that server fans are sensitive to supply air flow changes
- Reducing the fan speed below the server threshold static pressure energizes the server fans. The increase in server fan energy can cancel and potentially exceed the HVAC fan energy reduction

Inspecting for the expected post installation system behavior does not always yield energy savings

- The air economizer was observed to be in operation longer than expected, yet the meter showed no savings
- The metered post-installation results triggered an investigation to discover what was negating the cooling savings associated with the economizer operation

A traditional inspection would have shown that the project was implemented as planed expecting the savings to be realized. However, application of the M&V process showed that no actual savings were being realized, and identified the need for final controls commissioning.

- VFD was much lower than the targeted value
- The economizer hours were higher than estimated
- The return air temperature was close to the target value
- The hot and cold aisle temperatures also approximated the targeted values

Benefits of the M&V Process

- Demonstrated a need for additional commissioning in order to realize the energy savings
- Identified the absence of energy savings even though the post-installation system behavior was better than expected
- Served as a tool to identify what was negating the fan and cooling energy savings
- Demonstrated the actual energy savings after the project was fully commissioned.

Verified Project Results

				Verified Savings [1]			Verified Savings [2]		
	M&V Target Savings			Co-Gen Plant Operating During Part-Peak and Peak Periods			Co-Gen Plant Not Operating		
Building 11 Data Center	Peak Demand [kW]	Electrical Energy [kWh/yr]	Electrical Energy Cost [$/yr]	Peak Demand [kW]	Electrical Energy [kWh/yr]	Electrical Energy Cost [$/yr]	Peak Demand [kW]	Electrical Energy [kWh/yr]	Electrical Energy Cost [$/yr]
Baseline Annual Usage	850	6,051,709	$701,998	850	6,051,709	$701,998	850	6,051,709	$701,998
Projected Annual Usage	796	5,186,867	$601,677	850	5,385,979	$624,774	629	4,892,644	$567,547
DCCCP ECM Savings	54	864,842	$100,322	0	665,730	$77,225	221	1,159,065	$134,452
DCCCP ECM Savings %	6.4%	14.3%	14.3%	0.0%	11.0%	11.0%	26.0%	19.2%	19.2%

[1] The savings presented the worst case scenario with the cogeneration plant running. See Finding 3 for specific details
[2] The savings presented the best case scenario with the cogeneration plant deactivated. See Finding 3 for specific details
[3] The peak demand savings are for the winter season part-peak period.

	Baseline	Post Installation
Total Facility Power	850	
IT Equipment Power	**573**	**573**
Verified Post Installation Facility Power		629
Power Usage Effectiveness **(PUE)**	**1.48**	**1.10**
Datacenter Efficiency **(DCE)**	**0.67**	**0.91**

The Green Grid Efficiency Metrics

1. Power Usage Effectiveness (**PUE**) = Total Facility Power ÷ IT Equipment Power

2. Data Center Efficiency (**DCE**) = IT Equipment Power ÷ Total Facility Power

Ideally these metrics will help determine if the existing data center can be optimized.

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IT Equipment Power includes load associated with IT equipment (storage, networks, monitors, workstations used to monitor or control data center)

Total Facility Power includes everything that supports the IT equipment (UPS, switch gear, cooling systems, pumps, and other load components such as lighting).

Data Center Control Program

- Objective is to optimize air management through better monitoring and improved controls
- Savings opportunities
  - Use of hot aisle/cold aisle configuration
  - Installing air-side economizers (3000+ hours)
  - Installing VFD on Computer Room Air Conditioning (CRAC) Units
  - Programming better cooling parameters
- Offers audits and incentives for equipment (wireless controls and CRAC-unit VFD) and better practices (air-side economizing and improved air management)

Questions?

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