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Using a Data Center Water Side Economizer on an existing facility to reduce water and energy usage

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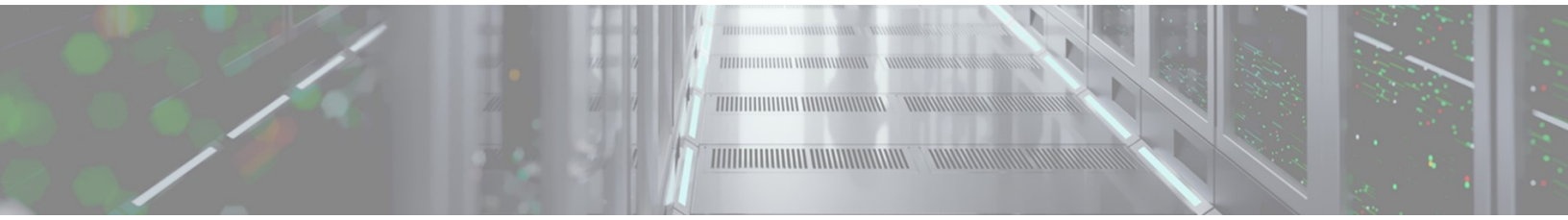

Introduction

EYP Mission Critical Facilities, Inc. (EYP MCF) worked with the client to reduce the power and water consumption of their fully operational data center(s). Considering different variables including cost, code compliance, maintaining existing reliability, space, and constructability while the data center is fully operational, the clients can obtain up to 25% of energy savings, and 7% on Water Usage Savings

Rising Realty Partners, owner of West 7 Center, formerly known as the Garland Center, a premier purposed-built mission-critical, co-location, and data center facility located at 1200 W.7th Street in downtown Los Angeles is one of the most energy-efficient data center following their recent central plant retrofit project. At a full load of 12-megawatt of data center load, the projected energy saving is approximately 6,900,000kWh per year after the retrofit project. With annualized mechanical partial PUE of 1.37, this data center at full load is among the top tier of its kind in the middle of downtown Los Angeles business district. The data center is located on the subterranean levels of a nine-story office building, it comprises of three subterranean levels. The bottom floor on lower level 3 is reserved for the critical mechanical and electrical infrastructure while the two top levels of lower level 1 and lower level 2 are the data center white space.

EYP MCF performed an energy audit and made recommendations on improving energy usage in the data center and the lowering of PUE (Power Usage Efficiency). Upon completion of the audit, EYP MCF recommended the installation of a water side economizer to the existing 4400-ton water-cooled chiller plant for energy savings and for the plant to be compliant with California Energy Code (Title 24). The existing central plant is an (N+1) chiller plant which consists of four (1100-ton) Trane centrifugal water-cooled chillers, four (3300 GPM) condenser water Pump, four (2600GPM) primary chilled water pumps, cooling towers, and multiple secondary chilled water pumps.

Energy Analysis and Benchmarking

The West 7 Center facility operations provided central plant energy usage trends from the Building Management System (BMS), water usage trending, and utility bills. During the study, the total building cooling load demand was approximately 761-tons, so at the time only one of the four chillers was required to meet the cooling demand for the building. Upon completion of benchmarking process, the data was analyzed, and the table and chart below represent the breakdown of the energy usage. (Figure 1)

Current Central Plant without Economizer		
Current Central Plant Cooling Load - 761 Tons		
Chiller chilled Supply water setpoint; 43 deg F		
Equipment Annual Energy Usage		
Equipment Type	kWh	
Cooling Compressor	4,069,425	67.5%
Tower / Condenser Fans	325,809	5.4%
Condenser Pumps	832,200	13.8%
Pumps	798,044	13.2%
Total	6,025,478	

Current Cental Plant with Economizer	
Annual Water Usage (1000 gals)	25,054

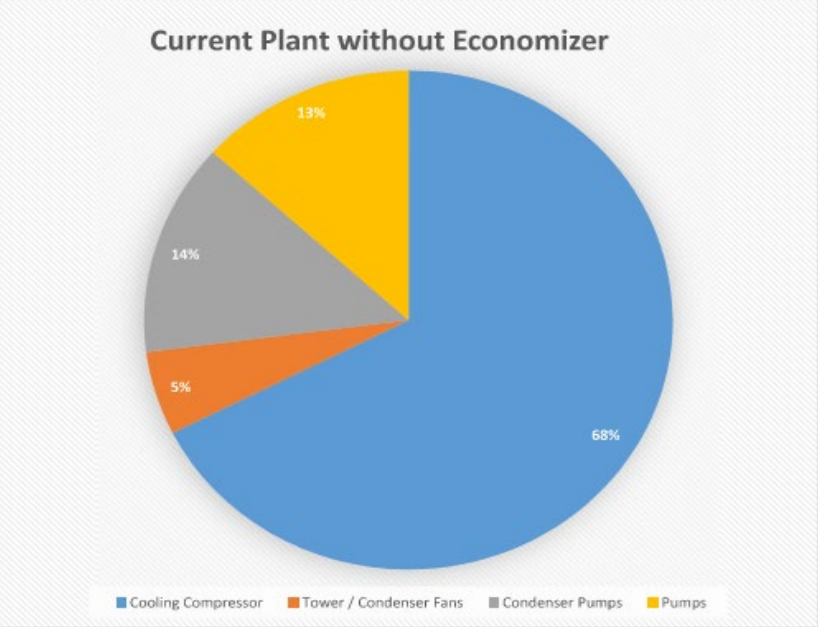

Figure 1 Central Plant Energy and water Usage Summary

Full Build Data Center Projected Energy Savings

The energy base model was created using Trane Trace Energy Modeling tool. The base model was calibrated and tested using actual field measurements and power consumption of the mechanical equipment at the site. The calibrated base model was then used to model future data center load profile and power and energy consumption. Figure 1 above represents the data center's full load energy usage without an economizer system and chilled water supply set point of 43-degree Fahrenheit.

The economizer system allows the chilled water system to operate at higher chilled water temperatures above the current design setpoint. Chilled water setpoint for economizer base model was set at 65-degree Fahrenheit driven by current Energy Code requirement and industry projected future trends. Figure 2 below represents the data center's load energy usage with an economizer system and a chilled water supply set point of 65-degree Fahrenheit.

Current Central Plant with Economizer		
Current Central Plant Cooling Load - 761 Tons		
Chiller chilled Supply water setpoint; 65 deg F		
Equipment Annual Energy Usage		
Equipment Type	kWh	
Cooling Compressor	2,389,283	53.5%
Tower / Condenser Fans	447,412	10.0%
Condenser Pumps	702,810	15.7%
Pumps	922,828	20.7%
Total	4,462,333	

Current Cental Plant with Economizer	
Annual Water Usage (1000 gals)	23,287

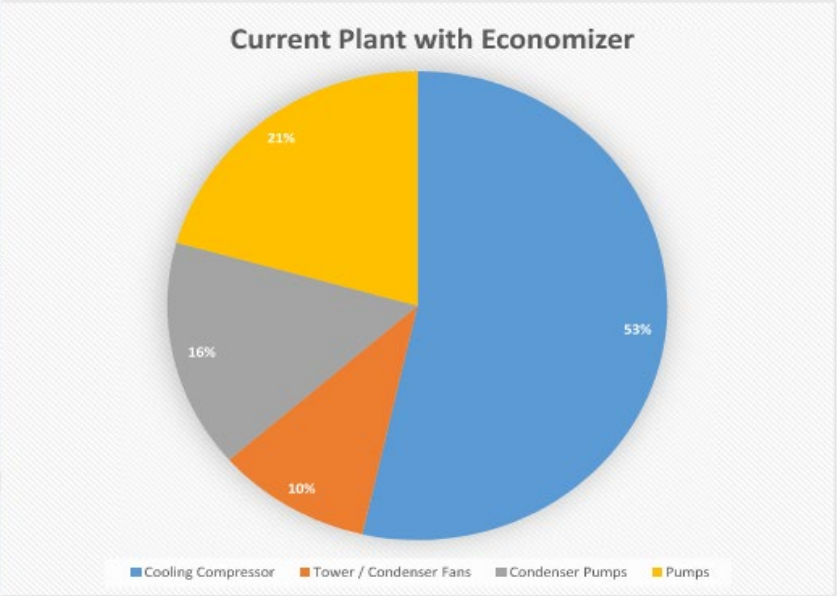

Figure 2 Data Center Energy Consumption with Economizer.

The projected annual energy savings of 1,563,145 kWh and water savings of 1.8-million gallons at the current load condition was computed and complied as summarized in Figure 3. However, the projected full implementation of the economizer will result in 6,944,371 kWh, and water usage savings of approximately 7-million gallons per year at full load.

Energy Saving With Economizer	
	kWh
Current Plant without Economizer	6,025,478
Current Plant with Economizer	4,462,333
Total Energy Savings	1,563,145

Water Usage Saving With Economizer	
	(1000 gals)
Current Plant without Economizer	25,054
Current Plant with Economizer	23,287
Total Water Usage Savings	1,767

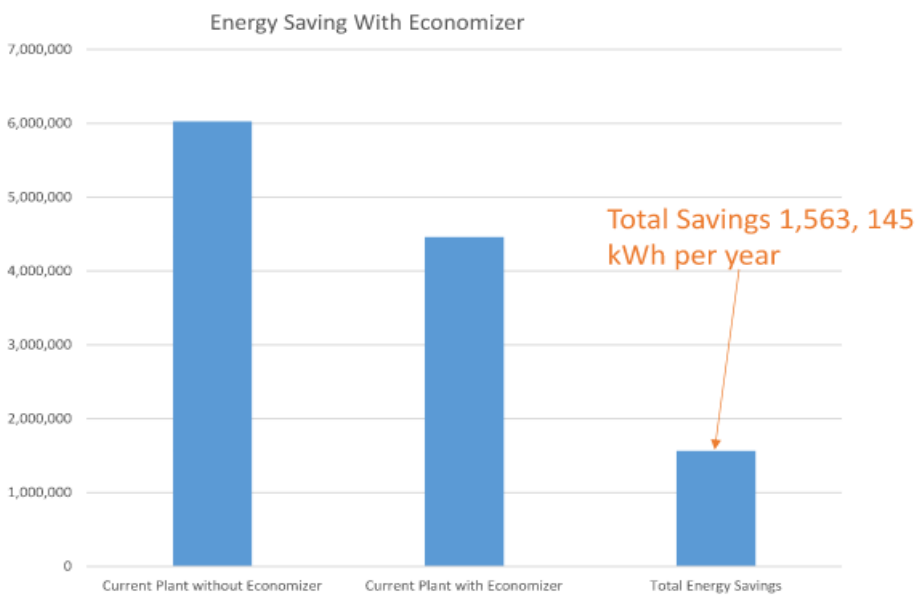

Figure 3 Energy Savings summary

Economizer Design Considerations

EYP Mission Critical Facilities Inc. (EYP MCF) in corroboration with Rising Realty Partners considered several factors in the design of the economizer retrofit project. Those factors included cost, code compliance, maintaining the reliability of the existing system, space availability, and constructability while the data center was still fully operational. Of all these factors, constructability and reliability were the two most important factors for Rising Realty Partners and EYP MCF. The original design intent was for chillers to operate in line-up formation of a primary pump, condenser pump, and cooling tower, connected to a common header, however, none of the pumps or the towers are dedicated to any chiller. EYP MCF recommended and designed an economizer system that was consistent with the original design intent. The economizer heat exchanger was to be connected in series with the chiller on both sides of chilled water and condenser water systems. Figure 4 below represents one line economizer heat exchanger connection diagram. As indicated both chilled water and condenser water are connected in series thus eliminating the cost of additional pumps. The system is designed for an economizer system to provide partial cooling to the chilled water and the chiller providing trim cooling to meet the setpoint. On the condenser side, the system is designed to maintain condenser water temperature through the chiller within the recommended manufacturer's range. This is accomplished by passing through warm water from the heat exchanger exit through the chiller and by modulating a 3-way valve controlled by the chiller control system.

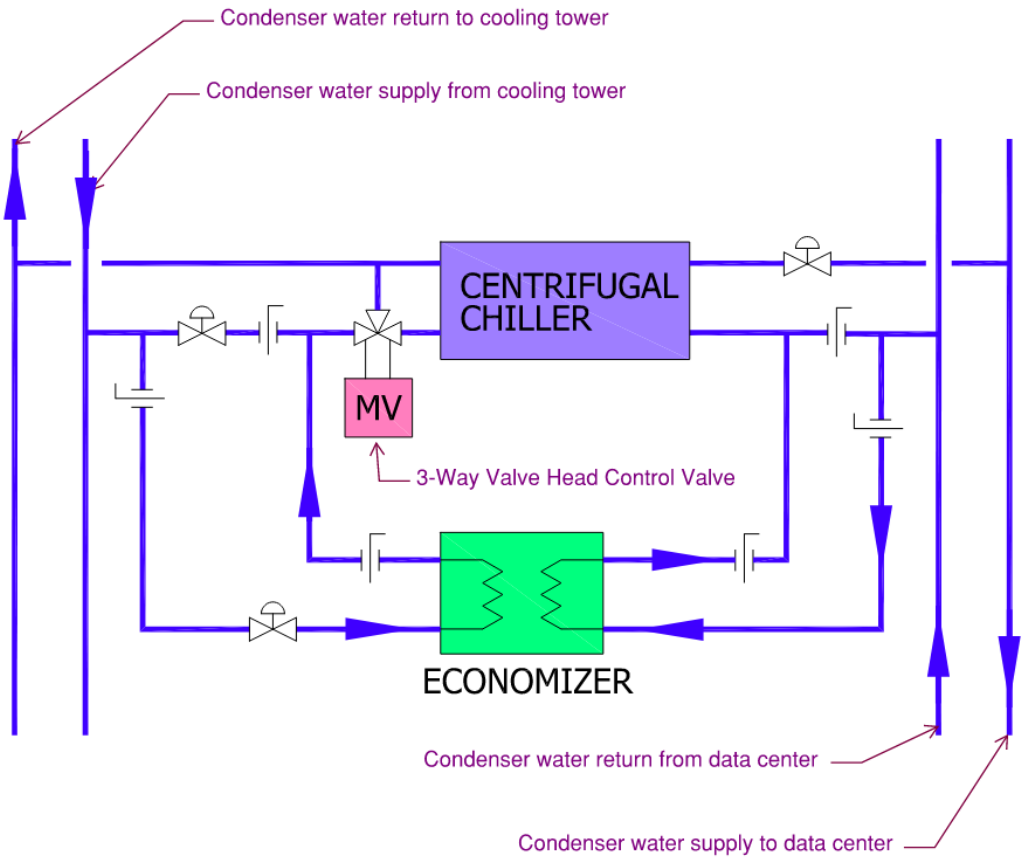

Figure 4 Heat Exchanger High Level connection diagram

Successful Project Completed During Shutdown

In the fall of 2019, the economizer retrofit construction commenced followed by vigorous balancing and testing, control system upgrade, and system functional testing. The project was completed in the fall of 2020. Figure 5 is a photo of one of the heat exchanger installations at the site while figure 6 is a photo of piping modification at the site.

Figure 5 Heat Exchanger installation photo

Figure 6 Economizer Piping Modified Installation Photo

Conclusion

The West 7 Center economizer retrofit project, is a sample case study of a successful retrofit project. It is projected to yield energy savings and maintain the operational reliability of the system. Projected annual energy and water savings and partial mechanical PUE of 1.37 makes this data center one of the most efficient data centers in downtown Los Angeles. This data center design by EYP Mission Critical Facilities Inc. (EYP MCF) provides operational flexibility as the information technology industry continues to evolve.

About Author

Gardson Githu, PE is a Senior Mechanical Engineer and Consultant at EYP Mission Critical Facilities.

Gardson's experience focuses on the design and analysis of HVAC systems for commercial, industrial, and Data Center infrastructure facilities. His experience includes new facilities design, retrofit design, and mechanical systems analysis. His project experience includes chilled water plants, thermal storage systems, fuel oil systems, and air handling systems. Gardson specialized in mechanical system energy optimization, data center risk site assessment and data center thermal mapping (computational fluid dynamic analysis).

He holds a Bachelor of Science degree in mechanical engineering from California State University Los Angeles, and a Master of Science degree in mechanical engineering with Themo-fluids option, from California State University Northridge.

He is a team member of the recently launched EYP Mission Critical Facilities and I3 Solutions Group Sustainability Initiative to offer a practical roadmap towards a Carbon Net-Zero data center by 2030.