STAFF PAPER

# Pumped Refrigerant Economizers for Use in Computer Rooms

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# ABSTRACT

California's *Building Energy Efficiency Standards* require the mechanical cooling equipment serving a computer room to be equipped with either an integrated air-side economizer or an integrated water-side economizer. A mechanical cooling system integrated with one of these features can provide cool air to the space without operating the mechanical cooling system when the outside conditions are cool enough to provide sufficient cooling to the space. This results in energy savings due to not having to operate a compressor to cool the air or water mechanically.

Pumped refrigerant economizing uses the same concept for energy savings, in that it bypasses the compressor for mechanical cooling by using a pump to move the refrigerant through the evaporator and condenser. The energy savings is achieved by the difference in energy consumption between the pump and compressor.

California Energy Commission staff proposes that the Commission approve a compliance option for pumped refrigerant-based economizers to be used as an alternative to water-side economizing for computer rooms. The proposed alternative is based on building simulations using CBECC-Com 3b (Build 717).

The proposed alternative of a pumped refrigerant economizer will allow this emerging technology to be used for standards compliance, where feasible. The benefit of this technology is not only energy savings, but water savings.

**Keywords**: California Energy Commission, refrigerant economizer, economizing, Liebert DSE, Emerson Network Power, AlaJor Engineering, *Building Energy Efficiency Standards*, CBECC-Com

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# EXECUTIVE SUMMARY

Public Resources Code, Section 25402.1 (b) requires that the California Energy Commission establish a formal process for certification of compliance options relating to new products, materials, or calculation methods that are usable for showing compliance with the *Building Energy Efficiency Standards*. In response to this requirement, Section 10-109 of the *Building Energy Efficiency Standards* establishes the process for introducing designs, materials, or devices that cannot be adequately modeled in any currently approved alternative calculation methods or that are not appropriately accounted for in currently approved compliance approaches.

Currently, the *Building Energy Efficiency Standards* prescriptively require that the mechanical cooling equipment serving a computer room be equipped with either an integrated air-side economizer or an integrated water-side economizer. A mechanical cooling system integrated with one of these features can provide cool air to the space without operating the mechanical cooling system provided the outside conditions are sufficiently cool. This results in energy savings due to not having to operate a compressor to mechanically cool the air or water.

Emerson Network Power (Emerson) used the established compliance option process of Section 10-109 to submit an application for approval of their Liebert DSE data center cooling system to be accounted for in the currently approved prescriptive compliance approach. This system features a pumped refrigerant economizer that follows the same principle of "economizing," in that it provides cool air to the space when the compressor is off or assisted and is still able to provide sufficient cooling. The Liebert DSE system uses pumps to move the refrigerant from the condenser to the evaporator, absorbing heat from the computer room and rejecting that heat to the outdoors. The energy savings is the difference in energy consumption between the pump and compressor. The proper outside conditions must be present for this process to work, just like air or water-side economizing, but unlike a water-side economizer the Liebert DSE system does not consume any water.

As part of their application Emerson included building simulation files comparing their system to a water-side economizer using the approved public domain software CBECC-Com. The results showed energy savings in 14 of the 16 climate zones. The climate zones where their system does not perform as well as a water-side economizer are climate zones 10 and 15.

Staff therefore recommends approval of this compliance option for pumped refrigerant based economizers as a prescriptive alternative to water-side economizing for computer rooms for climate zones 1-9, 11-14 and 16. This proposed alternative will provide energy savings in 14 out of the 16 climate zones, and will offset the use of water that would otherwise be consumed by the installation of a water-side economizer.

# Introduction

This report presents California Energy Commission staff's recommendation for approval of a compliance option for the Liebert DSE data center cooling system for computer rooms. The compliance option is based on energy simulations using approved public domain software CBECC-Com 3b (Build 717) that shows energy savings in 14 of the 16 climate zones for computer rooms that use a pumped refrigerant economizer opposed to a water-side economizer.

## Compliance Options

Public Resources Code, Section 25402.1 (b) requires the California Energy Commission to establish a formal certification process for compliance options relating to new products, materials, or calculation methods that are usable for showing compliance with the *Building Energy Efficiency Standards* (Standards). In response to this requirement of the Public Resources Code, Section 10-109 of the Standards establishes the process for introducing designs, materials, or devices that cannot be adequately modeled in any currently approved alternative calculation methods or that are not appropriately accounted for in the current approved compliance approaches.

The compliance option process enables the use of new or additional products, materials, designs, or procedures for demonstrating compliance with applicable building standards. In doing so, the process encourages market innovation and allows the Energy Commission to respond to changes in building design, construction, installation, and enforcement.

## Compliance Option for Refrigerant Economizers

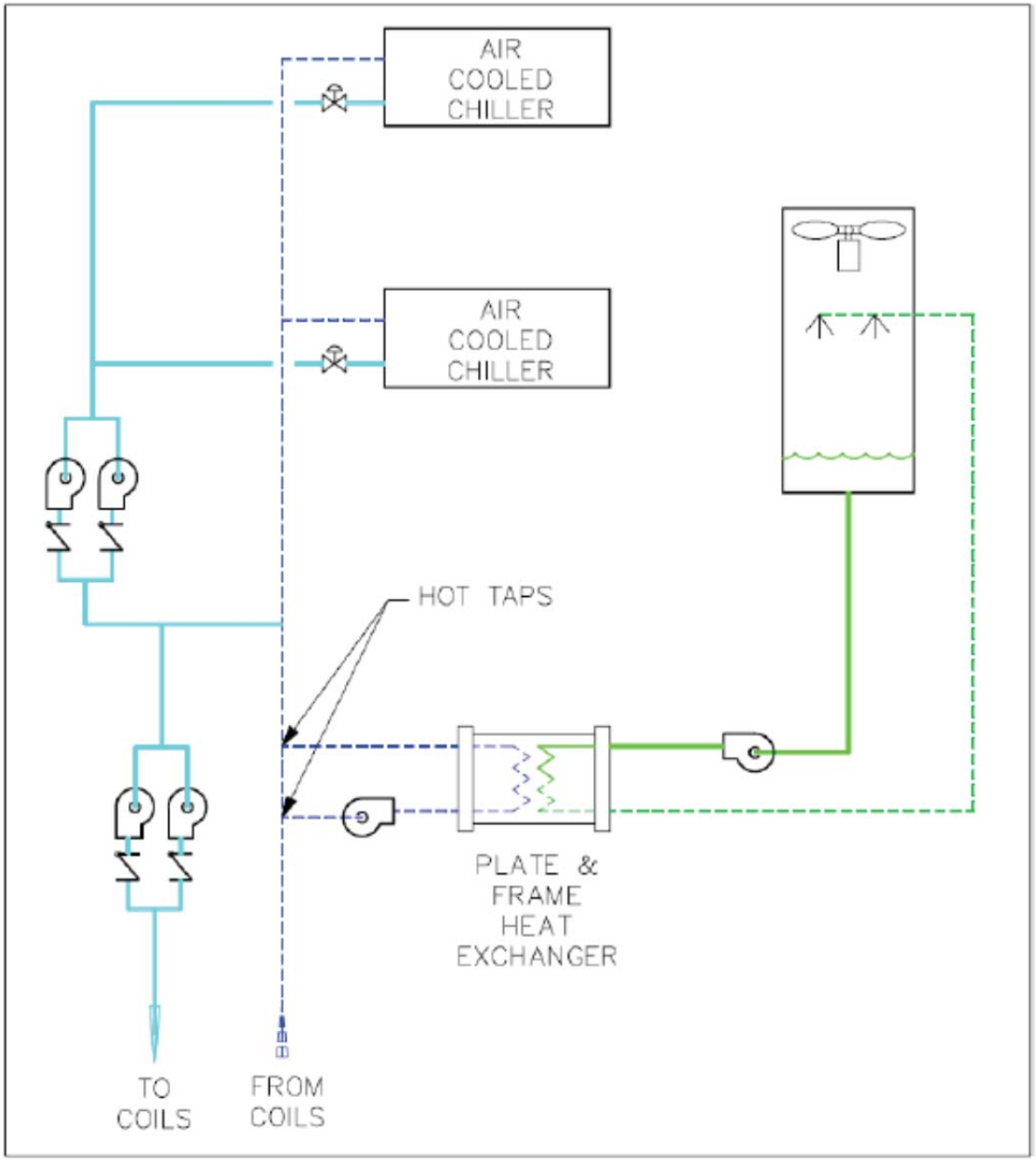
To comply with the Standards, mechanical cooling equipment serving computer rooms must be equipped with an integrated air-side or water-side economizer. The choice of air-side or water-side economization depends on the mechanical cooling system type.

Chilled water systems are a type of mechanical cooling that has an integrated water-side economizer and takes advantage of cooler outside conditions to provide cooling to the space. Generally, during favorable conditions, the chiller can be turned off, and the cooling tower provides the means of cooling the chilled water used to cool the space. The water-side economizer loop can also precool the supply air to help lower the load to the chiller and reduce energy use when the cooling load cannot be satisfied with the economizer alone.

When the water-side economizer is enabled, pumps are used to move the water between the cooling tower and the heat exchanger. The "economizing" happens in

the form of energy savings due to the chiller being off or assisted and still being able to provide sufficient cooling to the space. Given the constant cooling load of a computer room due to always-on heat-generating electronic equipment, these economizing conditions appear on most days and can be very favorable in certain climate zones.

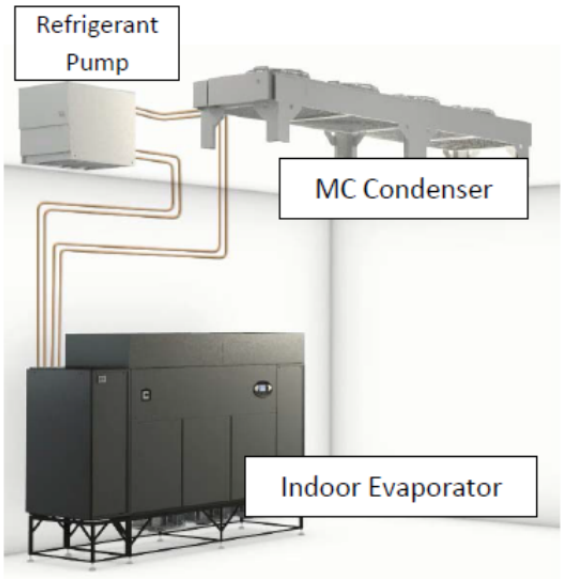
**Figure 1: Example of Water-Side Economizer on a Chilled Water Plant**




Source: *2013 Nonresidential Compliance Manual*

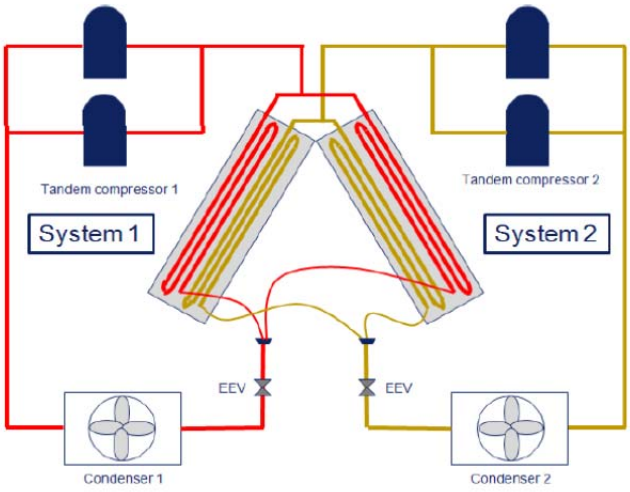
Pumped refrigerant economizing follows the same principle of "economizing" in that it provides cooling when the compressor is off or assisted and still being able to provide sufficient cooling. The Liebert DSE data center cooling system features a pumped refrigerant economizer that uses pumps to move the refrigerant from the condenser to the evaporator, absorbing heat from the computer room and rejecting that heat to the outdoors. The proper outside conditions must be present for this process to work; just like water-side economizing but unlike a water-side economizer, this system does not consume any water.

**Figure 2: Emerson Pumped Refrigerant Component Layout**




Source: Emerson Proposal to Include Refrigerant Economizers in Title 24

**Figure 3: Emerson Pumped Refrigerant Schematic**




Source: Emerson Response to Energy Commission Questions

# Staff Evaluation

## Computer Rooms and the Standards

Prior to the *2008 Standards*, process loads were generally considered exempt from the standards. The Standards define a *process load* as a load due to an "activity or treatment that is not related to the space conditioning, lighting, service water heating or ventilation of a building as it relates to human occupancy"[1]. The Standards began to regulate process loads in 2008 with requirements for refrigerated warehouses. The *2013 Standards* added requirements for computer rooms and other process load types.

## Review of Computer Room Economizing

The Standards define a computer room as "a room whose primary function is to house electronic equipment and that has a design equipment power density exceeding 20 watts per square foot of conditioned space."[1]

Computer rooms have a unique set of design requirements necessary for controlling key indoor air quality features such as dew point, temperature, and relative humidity. The electronic equipment (computers, servers, networking equipment) housed in these areas are sensitive to these variables in that they may fail due to high heat or electrostatic charge. Along with controlling the air quality, personnel must exercise caution, for example, by implementing personal grounding practices to avoid damaging the equipment or components.

Direct air economizing is a cost-effective option for computer rooms; however some care must be exercised depending on the air source. Certain contaminants, such as dust, may be introduced through poor outdoor air quality. Air-to-air heat exchangers can be used to control outdoor air contaminants and prevent them from entering the computer room, but at an added cost and consequently lower efficiency due to the heat exchange. It was been shown to still be cost-effective, however.

Water-side economizing is more desirable than air-side economizing for large data centers. An advantage to this type of economizing versus air-side is improved control of the indoor environment, such as humidity and dust particles, by avoiding the introduction of large quantities of outside air.

Pumped refrigerant economizing has similar advantages to water-side systems. Indoor environments can be better controlled by not introducing outdoor air. These systems

1 *2013 Building Energy Efficiency Standards,* Title 24, Part 6, Section 100.1.

also reduce the amount of equipment (such as pumps, fans, cooling towers) needed to operate in full or partial economizer modes.

# Results of Refrigerant Economizer Analysis

As part of the Emerson submittal package, Christian Hurd of AlaJor Engineering, Inc. performed a simulation analysis comparing the Liebert DSE system to a chilled water system with an integrated water-side economizer. The results showed that the Liebert DSE system outperformed the chilled water system with an integrated water-side economizer in 14 of the 16 California climate zones.

The method used by AlaJor Engineering, Inc. was to create a baseline energy budget by using the Energy Commission's public domain software CBECC-Com (Build 717). Once a baseline energy budget was established, the proposed Liebert DSE model was created using the CBECC-Com software, by extracting the IDF model (IDF is a format used by EnergyPlus) and then adding custom curves for the Liebert DSE equipment. The custom curves were developed from a regression analysis of Liebert pumped refrigerant system data, following the AHRI 1360 standard used for determining the efficiency rating. The researchers then simulated the proposed model.

Once both models were created and simulated, the results were extracted to the Exceptional Design Compliance - End-Use Summary Comparison spreadsheet. An excerpt of the spreadsheet is shown below where the results for each climate zone can be seen:

**Table 1: End-Use Summary Comparison – All Climate Zones**

| | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| Climate Zone 1 | Space Cooling | 1,073.5 | 1,333.2 | 1,278.1 | 1,643.2 | (310.1) |
| | Fans | 949.5 | 1,186.3 | 285.0 | 358.6 | 827.7 |
| | Lighting | 42.7 | 56.8 | 42.7 | 56.8 | - |
| | Pumps | 197.5 | 242.8 | - | - | 242.8 |
| | Heat Rejection | 29.4 | 43.4 | - | - | 43.4 |
| | Compliance Total | 2,292.5 | 2,862.4 | 1,605.8 | 2,058.6 | 803.8 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,802.2 | 7,925.0 | 9,802.2 | - |
| | Total | 10,217.6 | 12,664.6 | 9,530.8 | 11,860.8 | 803.8 |
| | | | | | | PASS |

| | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| Climate Zone 2 | Space Cooling | 1,105.9 | 1,415.3 | 1,468.8 | 2,006.5 | (591.2) |
| | Fans | 891.2 | 1,114.1 | 427.9 | 539.3 | 574.8 |
| | Lighting | 42.7 | 56.2 | 42.7 | 56.2 | - |
| | Pumps | 189.5 | 230.0 | - | - | 230.0 |
| | Heat Rejection | 48.1 | 72.3 | - | - | 72.3 |
| | Compliance Total | 2,277.4 | 2,887.9 | 1,939.4 | 2,602.0 | 285.9 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,737.3 | 7,925.0 | 9,737.3 | - |
| | Total | 10,202.4 | 12,625.2 | 9,864.4 | 12,339.3 | 285.9 |
| | | | | | | PASS |

| Climate Zone 3 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,064.0 | 1,313.5 | 1,654.1 | 2,119.3 | (805.8) |
| | Fans | 888.1 | 1,110.8 | 171.9 | 214.9 | 895.9 |
| | Lighting | 42.8 | 63.5 | 42.8 | 63.5 | - |
| | Pumps | 197.1 | 239.3 | - | - | 239.3 |
| | Heat Rejection | 41.3 | 58.6 | - | - | 58.6 |
| | Compliance Total | 2,233.3 | 2,785.7 | 1,868.9 | 2,397.7 | 388.1 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,611.6 | 7,925.0 | 9,611.6 | - |
| | Total | 10,158.4 | 12,397.4 | 9,793.9 | 12,009.3 | 388.1 |
| | | | | | | PASS |

| Climate Zone 4 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,116.2 | 1,390.5 | 1,524.0 | 2,014.3 | (623.7) |
| | Fans | 929.1 | 1,155.2 | 428.8 | 542.2 | 613.0 |
| | Lighting | 42.7 | 55.6 | 42.7 | 55.6 | - |
| | Pumps | 190.8 | 229.0 | - | - | 229.0 |
| | Heat Rejection | 53.1 | 75.8 | - | - | 75.8 |
| | Compliance Total | 2,332.0 | 2,906.1 | 1,995.5 | 2,612.1 | 294.0 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,592.8 | 7,925.0 | 9,592.8 | - |
| | Total | 10,257.0 | 12,498.9 | 9,920.5 | 12,204.9 | 294.0 |
| | | | | | | PASS |

| Climate Zone 5 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,090.4 | 1,345.3 | 1,417.1 | 1,827.2 | (481.9) |
| | Fans | 955.4 | 1,196.8 | 430.9 | 542.5 | 654.3 |
| | Lighting | 42.7 | 56.2 | 42.7 | 56.2 | - |
| | Pumps | 190.2 | 229.6 | - | - | 229.6 |
| | Heat Rejection | 38.0 | 55.0 | - | - | 55.0 |
| | Compliance Total | 2,316.7 | 2,882.8 | 1,890.6 | 2,425.8 | 457.0 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,638.4 | 7,925.0 | 9,638.4 | - |
| | Total | 10,241.7 | 12,521.2 | 9,815.6 | 12,064.2 | 457.0 |
| | | | | | | PASS |

| Climate Zone 6 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,113.6 | 1,369.5 | 1,584.6 | 1,996.1 | (626.6) |
| | Fans | 870.9 | 1,076.5 | 428.4 | 541.6 | 534.9 |
| | Lighting | 42.7 | 57.1 | 42.7 | 57.1 | - |
| | Pumps | 197.5 | 236.6 | - | - | 236.6 |
| | Heat Rejection | 68.0 | 89.1 | - | - | 89.1 |
| | Compliance Total | 2,292.7 | 2,828.8 | 2,055.7 | 2,594.8 | 234.0 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,565.6 | 7,925.0 | 9,565.6 | (0.0) |
| | Total | 10,217.7 | 12,394.3 | 9,980.7 | 12,160.4 | 233.9 |
| | | | | | | PASS |

| Climate Zone 7 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,113.7 | 1,409.2 | 1,607.3 | 2,063.8 | (654.6) |
| | Fans | 884.7 | 1,112.8 | 426.9 | 549.3 | 563.5 |
| | Lighting | 42.7 | 57.4 | 42.7 | 57.4 | - |
| | Pumps | 195.7 | 238.6 | - | - | 238.6 |
| | Heat Rejection | 65.2 | 87.6 | - | - | 87.6 |
| | Compliance Total | 2,302.0 | 2,905.6 | 2,076.9 | 2,670.5 | 235.0 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,776.8 | 7,925.0 | 9,776.7 | 0.0 |
| | Total | 10,227.0 | 12,682.3 | 10,001.9 | 12,447.3 | 235.1 |
| | | | | | | PASS |

| Climate Zone 8 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,128.2 | 1,408.8 | 1,609.7 | 2,079.7 | (670.9) |
| | Fans | 893.2 | 1,092.1 | 426.6 | 537.5 | 554.6 |
| | Lighting | 42.7 | 57.1 | 42.7 | 57.1 | - |
| | Pumps | 189.9 | 228.4 | - | - | 228.4 |
| | Heat Rejection | 64.1 | 86.1 | - | - | 86.1 |
| | Compliance Total | 2,318.1 | 2,872.6 | 2,079.0 | 2,674.3 | 198.3 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,655.5 | 7,925.0 | 9,655.5 | - |
| | Total | 10,243.1 | 12,528.1 | 10,004.0 | 12,329.8 | 198.3 |
| | | | | | | PASS |

| Climate Zone 9 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,139.2 | 1,411.4 | 1,629.2 | 2,074.7 | (663.3) |
| | Fans | 875.1 | 1,067.7 | 429.8 | 542.6 | 525.1 |
| | Lighting | 42.7 | 56.3 | 42.7 | 56.3 | - |
| | Pumps | 191.1 | 230.0 | - | - | 230.0 |
| | Heat Rejection | 70.9 | 94.9 | - | - | 94.9 |
| | Compliance Total | 2,318.9 | 2,860.2 | 2,101.7 | 2,673.5 | 186.7 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,516.6 | 7,925.0 | 9,516.6 | - |
| | Total | 10,243.9 | 12,376.8 | 10,026.7 | 12,190.1 | 186.7 |
| | | | | | | PASS |

| Climate Zone 10 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,059.0 | 1,359.2 | 1,669.6 | 2,231.7 | (872.5) |
| | Fans | 938.6 | 1,158.3 | 434.1 | 546.6 | 611.7 |
| | Lighting | 42.7 | 55.6 | 42.7 | 55.6 | - |
| | Pumps | 165.3 | 195.8 | - | - | 195.8 |
| | Heat Rejection | 42.8 | 63.2 | - | - | 63.2 |
| | Compliance Total | 2,248.3 | 2,832.1 | 2,146.4 | 2,834.0 | (1.8) |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,598.6 | 7,925.0 | 9,598.6 | - |
| | Total | 10,173.3 | 12,430.7 | 10,071.4 | 12,432.5 | (1.8) |
| | | | | | | FAIL |

| Climate Zone 11 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,181.0 | 1,526.7 | 1,666.1 | 2,332.6 | (806.0) |
| | Fans | 1,076.1 | 1,308.7 | 429.3 | 541.3 | 767.4 |
| | Lighting | 42.7 | 56.5 | 42.7 | 56.5 | - |
| | Pumps | 180.4 | 218.7 | - | - | 218.7 |
| | Heat Rejection | 54.3 | 79.2 | - | - | 79.2 |
| | Compliance Total | 2,534.5 | 3,189.7 | 2,138.1 | 2,930.4 | 259.3 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,884.7 | 7,925.0 | 9,884.7 | - |
| | Total | 10,459.5 | 13,074.4 | 10,063.1 | 12,815.1 | 259.3 |
| | | | | | | PASS |

| Climate Zone 12 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,126.7 | 1,454.8 | 1,577.1 | 2,170.3 | (715.6) |
| | Fans | 927.8 | 1,163.7 | 426.0 | 537.8 | 625.9 |
| | Lighting | 42.7 | 56.2 | 42.7 | 56.2 | - |
| | Pumps | 191.1 | 230.1 | - | - | 230.1 |
| | Heat Rejection | 53.7 | 78.7 | - | - | 78.7 |
| | Compliance Total | 2,342.0 | 2,983.5 | 2,045.7 | 2,764.4 | 219.2 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,785.6 | 7,925.0 | 9,785.6 | - |
| | Total | 10,267.0 | 12,769.2 | 9,970.7 | 12,550.0 | 219.2 |
| | | | | | | PASS |

| Climate Zone 13 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,145.7 | 1,464.9 | 1,684.2 | 2,299.9 | (835.0) |
| | Fans | 911.6 | 1,122.1 | 429.0 | 539.8 | 582.2 |
| | Lighting | 42.7 | 56.3 | 42.7 | 56.3 | - |
| | Pumps | 189.3 | 229.5 | - | - | 229.5 |
| | Heat Rejection | 57.5 | 83.7 | - | - | 83.7 |
| | Compliance Total | 2,346.8 | 2,956.5 | 2,155.9 | 2,896.0 | 60.4 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,781.4 | 7,925.0 | 9,781.4 | - |
| | Total | 10,271.8 | 12,737.8 | 10,080.9 | 12,677.4 | 60.4 |
| | | | | | | PASS |

| Climate Zone 14 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,143.7 | 1,457.3 | 1,727.8 | 2,404.3 | (947.0) |
| | Fans | 1,021.0 | 1,269.5 | 450.2 | 562.9 | 706.6 |
| | Lighting | 42.7 | 55.8 | 42.7 | 55.8 | - |
| | Pumps | 182.4 | 220.7 | - | - | 220.7 |
| | Heat Rejection | 35.4 | 57.3 | - | - | 57.3 |
| | Compliance Total | 2,425.2 | 3,060.6 | 2,220.7 | 3,023.0 | 37.6 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,774.9 | 7,925.0 | 9,774.9 | - |
| | Total | 10,350.2 | 12,835.5 | 10,145.7 | 12,797.9 | 37.6 |
| | | | | | | PASS |

| Climate Zone 15 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,227.9 | 1,575.5 | 1,996.8 | 2,671.7 | (1,096.1) |
| | Fans | 834.3 | 1,003.9 | 421.1 | 527.1 | 476.8 |
| | Lighting | 42.7 | 55.8 | 42.7 | 55.8 | - |
| | Pumps | 182.9 | 219.5 | - | - | 219.5 |
| | Heat Rejection | 78.9 | 107.9 | - | - | 107.9 |
| | Compliance Total | 2,366.6 | 2,962.7 | 2,460.6 | 3,254.6 | (291.9) |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,702.3 | 7,925.0 | 9,802.2 | (99.9) |
| | Total | 10,291.6 | 12,665.0 | 10,385.6 | 13,056.8 | (391.8) |
| | | | | | | FAIL |

| Climate Zone 16 | End Use | Baseline Waterside Economizer | | DSE Proposed Design - Custom Curves | | |
|---|---|---|---|---|---|---|
| | | MWh | TDV kBtuh/ft^2 | MWh | TDV kBtuh/ft^2 | TDV Margin |
| | Space Cooling | 1,118.6 | 1,438.3 | 1,297.0 | 1,824.4 | (386.1) |
| | Fans | 1,067.7 | 1,311.4 | 472.7 | 591.1 | 720.3 |
| | Lighting | 42.7 | 56.3 | 42.7 | 56.3 | - |
| | Pumps | 185.8 | 223.4 | - | - | 223.4 |
| | Heat Rejection | 29.7 | 52.5 | - | - | 52.5 |
| | Compliance Total | 2,444.5 | 3,081.9 | 1,812.4 | 2,471.7 | 610.1 |
| | | | | | | |
| | Interior Equipment | 7,925.0 | 9,749.2 | 7,925.0 | 9,749.2 | (0.0) |
| | Total | 10,369.5 | 12,831.0 | 9,737.4 | 12,221.0 | 610.1 |
| | | | | | | PASS |

Source: *Proposal to Include Refrigerant Economizers in the California Energy Commission 2013 Building Energy Efficiency Standards.*

## Public Review of Refrigerant Economizer Analysis

The entire submittal packaged was posted for a 60-day public review and comment period, including the simulation run files, end-use summary comparison, and custom curves.

After the 60-day public review and comment period was completed, only one comment was docketed. The commenter, Mark Hydeman from Taylor Engineering, was the primary author of the original Codes and Standards Enhancement Initiative (CASE) report that was the basis of the *2013 Standards* computer room requirements, and he expressed that the "proposed energy savings calculations are reasonable." Mr. Hydeman, did have some concerns with a lack of both scope and clarity, however, and included recommended changes to the submitted materials.

## Proposed Alternative for Computer Room Economizing

Staff proposes that an alternative to the prescriptive requirement found in Section 140.9(a)1B be given for pumped refrigerant economizers installed in Climate Zones 1-9, 11-14, and 16. This alternative prescriptive requirement will have little impact in the implementation compared to the existing requirement. Some changes to the existing compliance forms will be needed.

When complying under the performance approach, the proposed design should assume the same default as a standard design chilled water system with an integrated water-side economizer. No further compliance credit should be granted for this system until a rule set is developed and incorporated into CBECC-Com.

## Conclusion

Staff proposes that pumped refrigerant economizers be allowed as an alternative component package. The proposed alternative will provide energy savings in 14 out of the 16 climate zones and will offset the use of water that will otherwise be consumed by the installation of a water-side economizer. Allowing the use of this technology is consistent with the compliance options process prescribed by Public Resources Code, Section 25402.1(b) and Section 10-109 of the *Building Energy Efficiency Standards*, which allows for the introduction of designs, materials, or devices that cannot be adequately modeled in the currently approved alternative calculation methods or are not appropriately accounted for the currently approved approaches.

# References

*ASHRAE Handbook – HVAC Applications 2007,* Chapter 17, DATA PROCESSING AND ELECTRONIC OFFICE AREAS.

CALIFORNIA ENERGY COMMISSION. *2013 Building Energy Efficiency Standards, Title 24, Part 6.*

CALIFORNIA ENERGY COMMISSION. *2013 Nonresidential Compliance Manual*, Chapter 10.

CALIFORNIA ENERGY COMMISSION. 2013 Codes and Standards Enhancement Initiative, Data Centers.

EMERSON NETWORK POWER. "Emerson Response to California Energy Commission Request for Additional Information and Questions."

EMERSON NETWORK POWER. "Proposal to Include Refrigerant Economizers in the California Energy Commission *2013 Building Energy Efficiency Standards.*"