



ANALYSIS OF PUMPED REFRIGERANT ECONOMIZERS

Supporting The California
Energy Commission Approval
of the Liebert® DSE™ System
for Use in California
Data Centers

Table of Contents

1. Executive Summary
2. Energy and Water Savings
 - Technology Comparison for Annual TDV Compliance Value
 - Liebert® DSETM Pumped Refrigerant Economizer vs. Water and Airside Economizer Annual TDV Compliance Values
 - Water and Airside Economizer Annual Water Consumption
3. How the Liebert DSE System Works
4. California Building Codes
5. Compliance Modeling Method
6. Project Approval Process
7. Summary
8. Appendix A - Exceptional Design Compliance Calculations for all 16 Climate Zones
9. Appendix B
10. Appendix C

Executive Summary

The California Energy Commission has approved the Liebert® EconoPhase™ Pumped Refrigerant Economizer used by the Liebert DSE thermal management system for use in California data centers under Title 24, as an alternative prescriptive method. The Liebert DSE system meets or exceeds the full intent of the CEC Title 24 Energy Code for Computer Rooms while additionally not requiring water for economization.

The California Energy Code (Title 24) now requires all data centers to meet the efficiency requirement of either one of three prescriptive economization methods (outside air economization, water economization or pumped refrigerant economization) or to demonstrate through the Exceptional Design Compliance method the proposed solution meets or exceeds the energy efficiency of the prescriptive methods. This Technical Note describes the data, calculations and modeling submitted to the CEC that led to approval for pumped refrigeration economization as a prescriptive option for data center cooling.

Energy and Water Savings

The Liebert® DSE™ data center cooling system with pumped refrigerant economization system is a break-through, disruptive technology that solves many building design issues for thermal management needs, and meets or exceeds the efficiency of most water and air economization methods. Specifically, it meets the requirement of full economization at 40° F outdoor temperatures, and in many cases full economization is achieved in most data centers at outdoor temperatures of 65° F or more.

The CEC modeling compared a water economizer system and air economization system to the Liebert DSE pumped refrigerant economizer system for all sixteen (16) climate zones in California. The modeling was completed by a third party engineering firm with PE licensure and LEED – AP qualification. The model used the Performance Compliance Approach – as specified in Section 140.1 of the Energy Code – with calculation methodology for a TDV (Time Dependent Valuation), a measure of energy usage employed by the CEC. The air economization system in the CEC program does not

limit the lower dew point of the entering outside air, and thus the comparison includes an evaluation using the standard CEC program without dew point control and a calculation with additional energy required when limiting the low end dew point of the outside air (at 41.9° F).

The results are summarized below in Charts 1 and 2, with details provided in Appendix A. The Liebert DSE system with EconoPhase pumped refrigerant economizer was shown to be more efficient than water economizers in every Climate Zone, except for zones 10 and 15, as well as more efficient in certain zones when compared to air economizers.

In terms of water consumption, the Liebert DSE system uses no water, offering an advantage over the other two economizer methods. The Liebert DSE system eliminates the need for water in the heat rejection process, resulting in substantial annual savings, as seen in Appendix A. A cooling system with a water economizer uses an average of 4.3 million gallons of water per year for a data center with an IT load of 1.2 MW. Additionally, an economizer, for the same data center, using outside air consumes on average 2.7 million gallons (with no lower dew point control) or 3.2 million

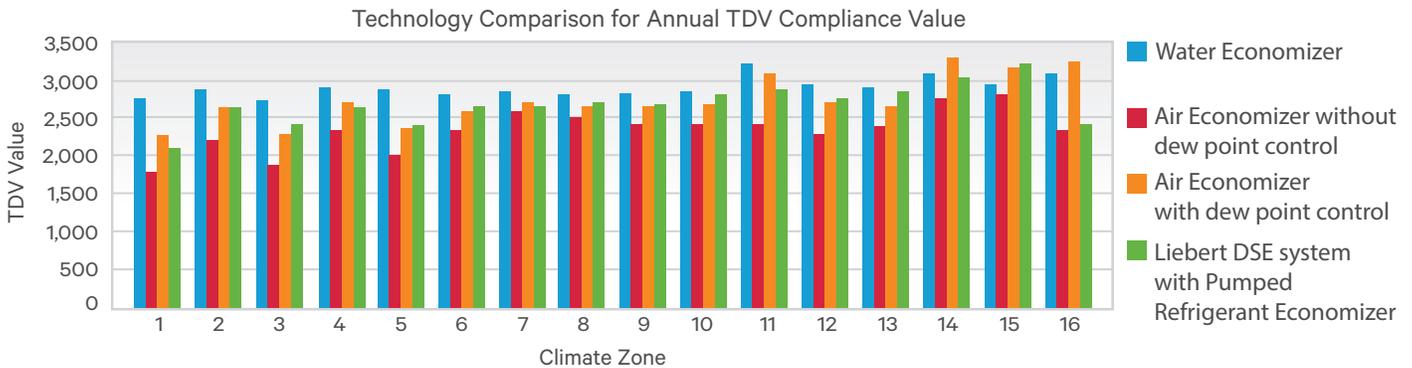


Chart 1

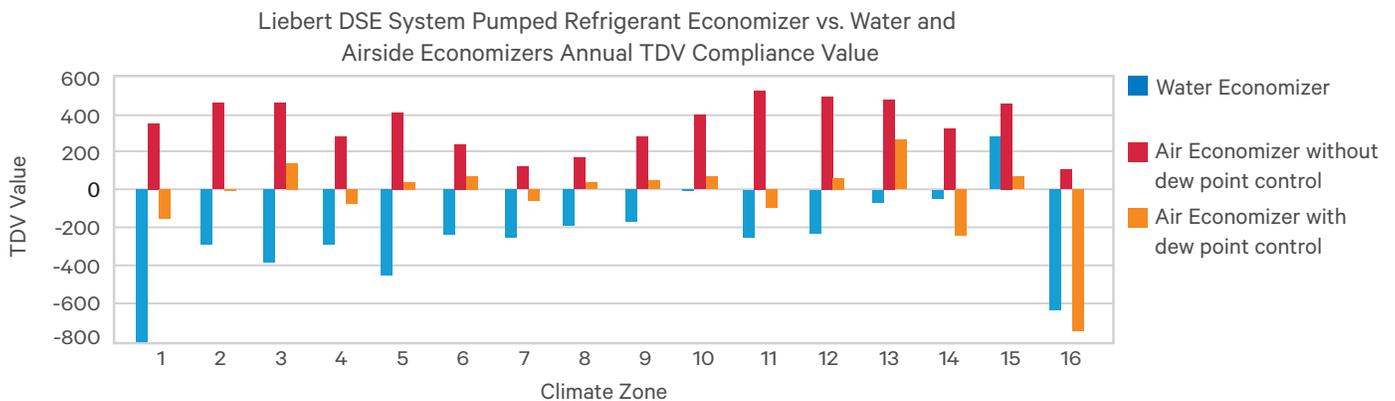


Chart 2

gallons (with lower dew point control) of water per year during the chiller operation. Other advantages of not utilizing water include a significant reduction in maintenance, chemical treatment, and risk of exposure to harmful water borne bacteria.

How the Liebert® DSE™ System Works

The Liebert DSE thermal management system is the world’s most efficient DX system. It consists of an indoor evaporator (CRAC-style unit), air cooled condenser and a refrigerant pump package, as shown in Diagram 1. The system operates like a standard air cooled Direct Expansion (DX) system, but when the criteria for economization are met,

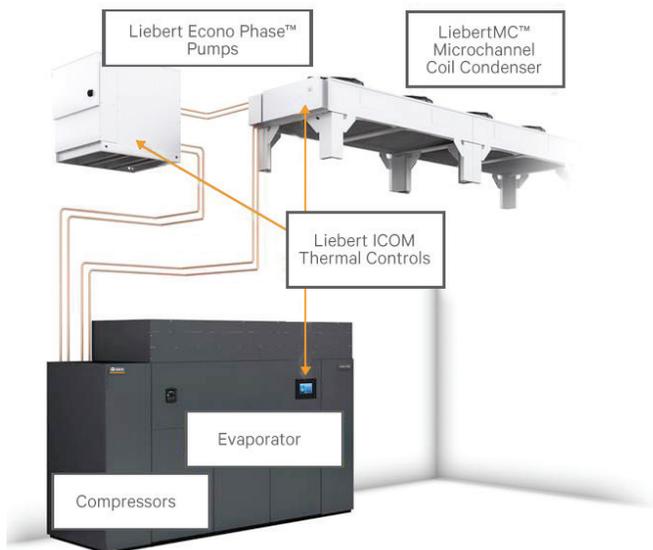


Diagram 1: Liebert DSE System Components

the compressors turn off and a refrigerant pump is turned on to move the refrigerant through the system and reject the heat of the data center. The refrigerant pump power is typically less than 5% of the energy of the compressor, but yields the same capacity.

Additionally, the Liebert DSE system uses Liebert iCOM™ thermal controls, which allow the unit to go into economization mode automatically when conditions meet the criteria to support the load with economization. This allows 100% of the available economization hours in the year to be utilized. Moreover, the economization mode is not based on a fixed outdoor temperature or chilled water temperature, and the unit is able to operate in economizer mode at much higher outdoor temperatures when the load varies (lower) or the return air conditions increases.

The system control will adjust the point of partial and full economization, based on the IT load and the return air temperatures, as seen in Chart 3 for operations in California Climate Zone 3 (San Francisco). This means economization may occur at higher ambient conditions, leading to a higher number of economization hours, compared to a chilled water system. A chiller plant typically has a fixed chilled water temperature that dictates the ambient temperature where economization occurs.

California Building Codes

The California 2013 Building Energy Efficiency Standards (Title 24), effective July 1, 2014, for Non Residential buildings (Subchapter 5) in Section 140.0(c) require either the performance compliance approach (energy budgets) in Section 140.1 or the prescriptive compliance approach in Section 140.2 for the Climate Zone in which the building will be located.

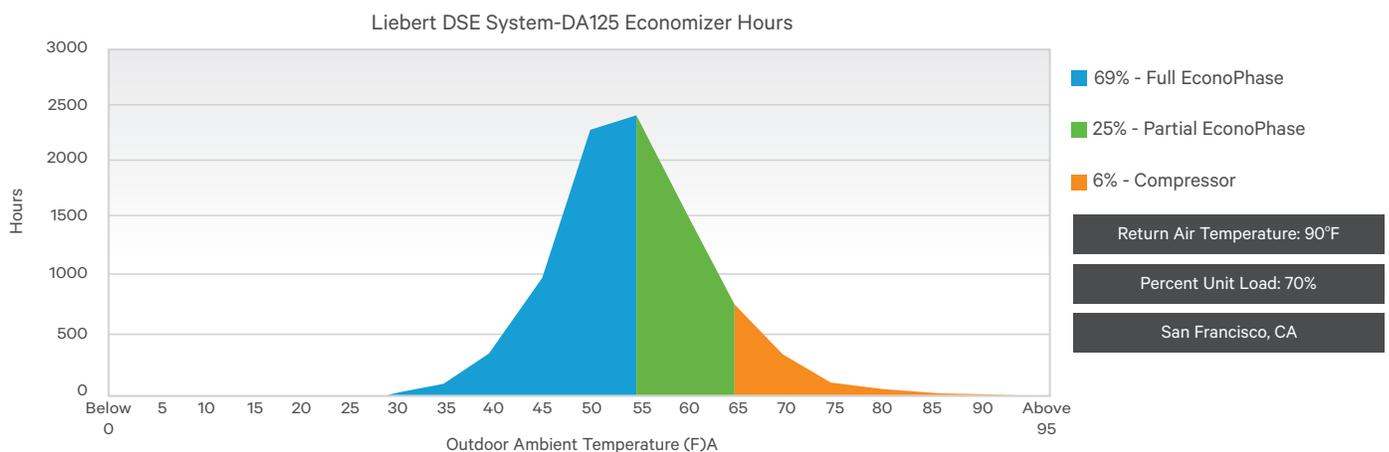


Chart 3

The prescriptive requirement for Computer Rooms is further defined in Section 140.9, where either integrated air economizers or integrated water economizers are capable of providing 100 percent of the expected system cooling load. For water economizers, this must be met with outside air temperatures of 40°F dry-bulb/35°F wet-bulb conditions and below.

Additionally, containment is required for rooms with design loads exceeding 175 kW per room. For the data center, this typically means you can drive return air temperatures to the cooling system higher than temperatures found in most office environments. It is not uncommon today to see this value exceed 95°F.

Compliance Modeling Method

Compliance Modeling requirement in section 140.1 is based on the 2013 Time Dependent Valuation (TDV), and for the Liebert® DSE™ system was conducted by AlaJor Engineering, Inc. Appendix A shows the results from the preliminary baseline and proposed models simulated for a project in all California Climate Zones. The models use a 1,200kW data center with standard redundancy assumptions (N+2) and conservative return air temperatures (80°F) with containment.

The baseline water economizer model was created utilizing the CEC's CBECC-Com (Build 717) and extracting the baseline IDF (Input Data File) model that was created. The extracted baseline IDF model was modified to remove the air economizer and added the water economizer. The model was simulated with EnergyPlus and the results extracted to the Exceptional Design Compliance - End Use Summary Comparison spreadsheet. The proposed Liebert DSE model was created utilizing the CEC's CBECC-Com (Build 717) and extracting the proposed IDF model that was created. The extracted proposed IDF model was modified and added custom curves for the Liebert DSE equipment, developed from a regression analysis from data provided for the operation for the Liebert EconoPhase™ pumped refrigerant system. The model was simulated and the results extracted to the *Exceptional Design Compliance - End Use Summary Comparison spreadsheet*.

For example, in Climate Zone 3 (San Francisco), the Liebert DSE system was shown to reduce TDV value by 388.1 compared to a water economizer and increase the TDV value by 140.3 compared to an airside economizer. It eliminated 4.063 million gallons of water usage compared to a water economizer and 1.943 million gallons compared to an airside economizer.

Approval Process for Projects with the Liebert DSE System

The CEC approved the inclusion of the Liebert EconoPhase pumped refrigerant economizer as a prescriptive option on September 9, 2015, as shown in the CEC's Blueprint newsletter, Issue 111 (see Appendix B).

The Liebert EconoPhase economizer is not yet accounted for in the CEC's performance software, so engineers and others wanting to use the Liebert DSE with EconoPhase pumped refrigerant economizer in California should follow this guideline:

If the project is complying using the performance approach, then the cooling system serving the computer room should be specified as a basic, efficient chilled water plant, with an integrated water economizer. The compliance documents can be used to show local government jurisdictions that the efficiency of the Liebert DSE is equivalent or better than the chilled water system and acceptable as a prescriptive alternative.

Summary

The use of refrigerant economizers provide significant benefits in California data centers. There is on average a 5% to 6% reduction in the TDV energy value, but more significantly it eliminates the water requirement for these data centers. The inclusion of a refrigerant economizer, such as the Liebert DSE system with Liebert EconoPhase pumped refrigerant economizer, in the prescriptive compliance method makes the adaption and implementation of this technology on par with water economization evaluations.

Appendix A - Exceptional Design Compliance Calculations for all 16 Climate Zones

| END USE | BASELINE WATERSIDE ECONOMIZER | | BASELINE AIRSIDE ECONOMIZER (CURRENT MODEL) | | BASELINE AIRSIDE ECONOMIZER (MODIFIED DP CONTROL) | | LIEBERT® DSE™ SYSTEM PROPOSED DESIGN - CUSTOM CURVES | LIEBERT DSE SYSTEM COMPARISON (POSITIVE - FAVORABLE) | | |
|----------------|-------------------------------|------------------------|---|-------------------------|---|-------------------------|--|--|-------------------------------------|----------------|
| | TDV Btuh /FT² | EST. WATER USAGE GAL/Y | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | TDV MARGIN VS. WATER ECON. | TDV MARGIN VS. AIR ECON. (MODIFIED) | |
| CLIMATE ZONE 1 | Space Cooling | 1,333.2 | - | 444.6 | - | 444.6 | | 1,643.2 | (310.1) | (1,198.7) |
| | Fans | 1,186.3 | - | 1,090.6 | - | 1,090.6 | | 358.6 | 827.7 | 732.1 |
| | Lighting | 56.8 | - | 63.3 | - | 63.3 | | 56.8 | - | 6.5 |
| | Pumps | 242.8 | - | 77.6 | - | 77.6 | | - | 242.8 | 77.6 |
| | Heat Rejection | 43.4 | - | 23.4 | - | 23.4 | | - | 43.4 | 23.4 |
| | Add for Low DP Control | - | - | - | - | 529.3 | | - | - | 529.3 |
| | Compliance Total | 2,862.4 | - | 1,699.4 | - | 2,228.7 | | 2,058.6 | 803.8 | 170.2 |
| | Interior Equipment | 9,802.2 | - | 9,802.2 | - | 9,802.2 | | 9,802.2 | - | - |
| | TOTAL | 12,664.6 | 3,875,000 | 11,501.6 | 940,069 | 12,030.9 | 1,244,185 | 11,860.8 | 803.8 | 170.2 |
| CLIMATE ZONE 2 | Space Cooling | 1,415.3 | - | 813.8 | - | 813.8 | | 2,006.5 | (310.1) | (1,198.7) |
| | Fans | 1,114.1 | - | 1,110.6 | - | 1,110.6 | | 539.3 | 827.7 | 732.1 |
| | Lighting | 56.2 | - | 63.3 | - | 63.3 | | 56.2 | (591.2) | 1,192.6) |
| | Pumps | 230.0 | - | 107.4 | - | 107.4 | | - | 574.8 | 571.3 |
| | Heat Rejection | 72.3 | - | 59.2 | - | 59.2 | | - | - | 7.0 |
| | Add for Low DP Control | - | - | - | - | 448.6 | | - | 230.0 | 107.4 |
| | Compliance Total | 2,887.9 | - | 2,154.3 | - | 2,602.9 | | 2,602.0 | 72.3 | 59.2 |
| | Interior Equipment | 9,737.3 | - | 9,737.3 | - | 9,737.3 | | 9,737.3 | - | 448.6 |
| | TOTAL | 12,625.2 | 4,260,000 | 11,891.6 | 2,108,000 | 12,340.2 | 2,560,241 | 12,339.3 | 285.9 | 0.9 |
| CLIMATE ZONE 3 | Space Cooling | 1,313.5 | - | 638.8 | - | 638.8 | | 2,119.3 | (805.8) | (1,480.5) |
| | Fans | 1,110.8 | - | 1,089.6 | - | 1,089.6 | | 214.9 | 895.9 | 874.7 |
| | Lighting | 63.5 | - | 63.5 | - | 63.5 | | 63.5 | - | - |
| | Pumps | 239.3 | - | 120.6 | - | 120.6 | | - | 239.3 | 120.6 |
| | Heat Rejection | 58.6 | - | 36.4 | - | 36.4 | | - | 58.6 | 36.4 |
| | Add for Low DP Control | - | - | - | - | 308.4 | | - | - | 308.4 |
| | Compliance Total | 2,785.7 | - | 1,948.9 | - | 2,257.3 | | 2,397.7 | 388.1 | (140.3) |
| | Interior Equipment | 9,611.6 | - | 9,611.6 | - | 9,611.6 | | 9,611.6 | - | - |
| | TOTAL | 12,397.4 | 4,063,160 | 11,560.6 | 1,670,000 | 11,869.0 | 1,943,161 | 12,009.3 | 388.1 | (140.3) |

Appendix A (cont.) - Exceptional Design Compliance Calculations for all 16 Climate Zones

| END USE | BASELINE WATERSIDE ECONOMIZER | | BASELINE AIRSIDE ECONOMIZER (CURRENT MODEL) | | BASELINE AIRSIDE ECONOMIZER (MODIFIED DP CONTROL) | | LIEBERT® DSE™ SYSTEM PROPOSED DESIGN - CUSTOM CURVES | LIEBERT DSE SYSTEM COMPARISON (POSITIVE - FAVORABLE) | |
|----------------|-------------------------------|------------------------|---|-------------------------|---|-------------------------|--|--|-------------------------------------|
| | TDV Btuh /FT² | EST. WATER USAGE GAL/Y | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | TDV MARGIN VS. WATER ECON. | TDV MARGIN VS. AIR ECON. (MODIFIED) |
| CLIMATE ZONE 4 | Space Cooling | 1,390.5 | - | 870.9 | - | 870.9 | 2,014.3 | (623.7) | (1,143.3) |
| | Fans | 1,155.2 | - | 1,221.4 | - | 1,221.4 | 542.2 | 613.0 | 679.2 |
| | Lighting | 55.6 | - | 63.3 | - | 63.3 | 55.6 | - | 7.7 |
| | Pumps | 229.0 | - | 118.0 | - | 118.0 | - | 229.0 | 118.0 |
| | Heat Rejection | 75.8 | - | 68.3 | - | 68.3 | - | 75.8 | 68.3 |
| | Add for Low DP Control | - | - | - | - | 332.1 | - | - | 332.1 |
| | Compliance Total | 2,906.1 | - | 2,341.9 | - | 2,674.0 | 2,612.1 | 294.0 | 62.0 |
| | Interior Equipment | 9,592.8 | - | 9,592.8 | - | 9,592.8 | 9,592.8 | - | - |
| | TOTAL | 12,498.9 | 4,378,000 | 11,934.8 | 2,449,000 | 12,266.9 | 2,805,930 | 12,204.9 | 294.0 |
| CLIMATE ZONE 5 | Space Cooling | 1,345.3 | - | 680.2 | - | 680.2 | 1,827.2 | (481.9) | (1,147.0) |
| | Fans | 1,196.8 | - | 1,124.1 | - | 1,124.1 | 542.5 | 654.3 | 581.6 |
| | Lighting | 56.2 | - | 63.8 | - | 63.8 | 56.2 | - | 7.7 |
| | Pumps | 229.6 | - | 105.2 | - | 105.2 | - | 229.6 | 105.2 |
| | Heat Rejection | 55.0 | - | 44.0 | - | 44.0 | - | 55.0 | 44.0 |
| | Add for Low DP Control | - | - | - | - | 385.5 | - | - | 385.5 |
| | Compliance Total | 2,882.8 | - | 2,017.3 | - | 2,402.8 | 2,425.8 | 457.0 | (23.0) |
| | Interior Equipment | 9,638.4 | - | 9,638.4 | - | 9,638.4 | 9,638.4 | - | - |
| | TOTAL | 12,521.2 | 4,003,000 | 12,041.2 | 1,785,000 | 12,041.2 | 2,137,256 | 12,064.2 | 457.0 |
| CLIMATE ZONE 6 | Space Cooling | 1,369.5 | - | 1,020.1 | - | 1,020.1 | 1,996.1 | (626.6) | (976.0) |
| | Fans | 1,076.5 | - | 1,040.8 | - | 1,040.8 | 541.6 | 534.9 | 499.2 |
| | Lighting | 57.1 | - | 63.5 | - | 63.5 | 57.1 | - | 6.4 |
| | Pumps | 236.6 | - | 155.6 | - | 155.6 | - | 236.6 | 155.6 |
| | Heat Rejection | 89.1 | - | 88.0 | - | 88.0 | - | 89.1 | 88.0 |
| | Add for Low DP Control | - | - | - | - | 166.9 | - | - | 166.9 |
| | Compliance Total | 2,828.8 | - | 2,368.0 | - | 2,534.9 | 2,594.8 | 234.0 | (59.9) |
| | Interior Equipment | 9,565.6 | - | 9,565.6 | - | 9,565.6 | 9,565.6 | (0.0) | (0.0) |
| | TOTAL | 12,394.3 | 4,258,000 | 12,100.5 | 2,932,000 | 12,100.5 | 3,144,342 | 12,160.4 | 233.9 |

Appendix A (cont.) - Exceptional Design Compliance Calculations for all 16 Climate Zones

| END USE | BASELINE WATERSIDE ECONOMIZER | | BASELINE AIRSIDE ECONOMIZER (CURRENT MODEL) | | BASELINE AIRSIDE ECONOMIZER (MODIFIED DP CONTROL) | | LIEBERT® DSE™ SYSTEM PROPOSED DESIGN - CUSTOM CURVES | LIEBERT DSE SYSTEM COMPARISON (POSITIVE - FAVORABLE) | |
|----------------|-------------------------------|------------------------|---|-------------------------|---|-------------------------|--|--|-------------------------------------|
| | TDV BTUH /FT² | EST. WATER USAGE GAL/Y | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | TDV MARGIN VS. WATER ECON. | TDV MARGIN VS. AIR ECON. (MODIFIED) |
| CLIMATE ZONE 7 | Space Cooling | 1,409.2 | - | 1,093.8 | - | 1,093.8 | 2,063.8 | (654.6) | (970.1) |
| | Fans | 1,112.8 | - | 1,166.7 | - | 1,166.7 | 549.3 | 563.5 | 617.4 |
| | Lighting | 57.4 | - | 64.0 | - | 64.0 | 57.4 | - | 6.6 |
| | Pumps | 238.6 | - | 161.6 | - | 161.6 | - | 238.6 | 161.6 |
| | Heat Rejection | 87.6 | - | 88.8 | - | 88.8 | - | 87.6 | 88.8 |
| | Add for Low DP Control | - | - | - | - | 144.3 | - | - | 144.3 |
| | Compliance Total | 2,905.6 | - | 2,574.9 | - | 2,719.2 | 2,670.5 | 235.0 | 48.6 |
| | Interior Equipment | 9,776.8 | - | 9,776.8 | - | 9,776.8 | 9,776.7 | 0.0 | 0.0 |
| TOTAL | 12,682.3 | 4,280,000 | 12,495.9 | 3,085,000 | 12,495.9 | 3,262,297 | 12,447.3 | 235.1 | 48.7 |
| CLIMATE ZONE 8 | Space Cooling | 1,408.8 | - | 1,062.6 | - | 1,062.6 | 2,079.7 | (670.9) | (1,017.1) |
| | Fans | 1,092.1 | - | 1,146.4 | - | 1,146.4 | 537.5 | 554.6 | 608.9 |
| | Lighting | 57.1 | - | 63.2 | - | 63.2 | 57.1 | - | 6.1 |
| | Pumps | 228.4 | - | 149.2 | - | 149.2 | - | 228.4 | 149.2 |
| | Heat Rejection | 86.1 | - | 85.6 | - | 85.6 | - | 86.1 | 85.6 |
| | Add for Low DP Control | - | - | - | - | 153.7 | - | - | 153.7 |
| | Compliance Total | 2,872.6 | - | 2,507.0 | - | 2,660.7 | 2,674.3 | 198.3 | (13.6) |
| | Interior Equipment | 9,655.5 | - | 9,655.5 | - | 9,655.5 | 9,655.5 | - | - |
| TOTAL | 12,528.1 | 4,312,000 | 12,316.2 | 3,019,000 | 12,316.2 | 3,208,878 | 12,329.8 | 198.3 | (13.6) |
| CLIMATE ZONE 9 | Space Cooling | 1,411.4 | - | 1,076.5 | - | 1,076.5 | 2,074.7 | (663.3) | (998.1) |
| | Fans | 1,067.7 | - | 1,044.6 | - | 1,044.6 | 542.6 | 525.1 | 502.0 |
| | Lighting | 56.3 | - | 63.1 | - | 63.1 | 56.3 | - | 6.8 |
| | Pumps | 230.0 | - | 149.2 | - | 149.2 | - | 230.0 | 149.2 |
| | Heat Rejection | 94.9 | - | 91.9 | - | 91.9 | - | 94.9 | 91.9 |
| | Add for Low DP Control | - | - | - | - | 219.4 | - | - | 219.4 |
| | Compliance Total | 2,860.2 | - | 2,425.3 | - | 2,644.7 | 2,673.5 | 186.7 | (28.8) |
| | Interior Equipment | 9,516.6 | - | 9,516.6 | - | 9,516.6 | 9,516.6 | - | - |
| TOTAL | 12,376.8 | 4,414,000 | 12,161.3 | 3,083,000 | 12,161.3 | 3,369,349 | 12,190.1 | 186.7 | (28.8) |

Appendix A (cont.) - Exceptional Design Compliance Calculations for all 16 Climate Zones

| END USE | BASELINE WATERSIDE ECONOMIZER | | BASELINE AIRSIDE ECONOMIZER (CURRENT MODEL) | | BASELINE AIRSIDE ECONOMIZER (MODIFIED DP CONTROL) | | LIEBERT® DSE™ SYSTEM PROPOSED DESIGN - CUSTOM CURVES | LIEBERT DSE SYSTEM COMPARISON (POSITIVE - FAVORABLE) | |
|-----------------|-------------------------------|------------------------|---|-------------------------|---|-------------------------|--|--|-------------------------------------|
| | TDV Btuh /FT² | EST. WATER USAGE GAL/Y | TDV KBTUH /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV KBTUH /FT² | TDV MARGIN VS. WATER ECON. | TDV MARGIN VS. AIR ECON. (MODIFIED) |
| CLIMATE ZONE 10 | Space Cooling | 1,359.2 | - | 1,055.0 | - | 1,055.0 | 2,231.7 | (872.5) | (1,176.7) |
| | Fans | 1,158.3 | - | 1,087.1 | - | 1,087.1 | 546.6 | 611.7 | 540.5 |
| | Lighting | 55.6 | - | 63.3 | - | 63.3 | 55.6 | - | 7.7 |
| | Pumps | 195.8 | - | 136.8 | - | 136.8 | - | 195.8 | 136.8 |
| | Heat Rejection | 63.2 | - | 82.7 | - | 82.7 | - | 63.2 | 82.7 |
| | Add for Low DP Control | - | - | - | - | 338.0 | - | - | 338.0 |
| | Compliance Total | 2,832.1 | - | 2,424.9 | - | 2,762.9 | 2,834.0 | (1.8) | (71.1) |
| | Interior Equipment | 9,598.6 | - | 9,598.6 | - | 9,598.6 | 9,598.6 | - | - |
| | TOTAL | 12,430.7 | 3,664,000 | 12,361.4 | 3,176,000 | 12,361.4 | 3,630,568 | 12,432.5 | (1.8) |
| CLIMATE ZONE 11 | Space Cooling | 1,526.7 | - | 1,004.3 | - | 1,004.3 | 2,332.6 | (806.0) | (1,328.3) |
| | Fans | 1,308.7 | - | 1,139.2 | - | 1,139.2 | 541.3 | 767.4 | 597.9 |
| | Lighting | 56.5 | - | 62.8 | - | 62.8 | 56.5 | - | 6.3 |
| | Pumps | 218.7 | - | 120.6 | - | 120.6 | - | 218.7 | 120.6 |
| | Heat Rejection | 79.2 | - | 76.1 | - | 76.1 | - | 79.2 | 76.1 |
| | Add for Low DP Control | - | - | - | - | 648.7 | - | - | 648.7 |
| | Compliance Total | 3,189.7 | - | 2,403.1 | - | 3,051.8 | 2,930.4 | 259.3 | 121.4 |
| | Interior Equipment | 9,884.7 | - | 9,884.7 | - | 9,884.7 | 9,884.7 | - | - |
| | TOTAL | 13,074.4 | 4,755,000 | 12,936.5 | 3,062,000 | 12,936.5 | 3,910,750 | 12,815.1 | 259.3 |
| CLIMATE ZONE 12 | Space Cooling | 1,454.8 | - | 923.1 | - | 923.1 | 2,170.3 | (715.6) | (1,247.2) |
| | Fans | 1,163.7 | - | 1,106.0 | - | 1,106.0 | 537.8 | 625.9 | 568.2 |
| | Lighting | 56.2 | - | 62.8 | - | 62.8 | 56.2 | - | 6.5 |
| | Pumps | 230.1 | - | 116.1 | - | 116.1 | - | 230.1 | 116.1 |
| | Heat Rejection | 78.7 | - | 71.8 | - | 71.8 | - | 78.7 | 71.8 |
| | Add for Low DP Control | - | - | - | - | 430.0 | - | - | 430.0 |
| | Compliance Total | 2,983.5 | - | 2,279.7 | - | 2,709.7 | 2,764.4 | 219.2 | (54.6) |
| | Interior Equipment | 9,785.6 | - | 9,785.6 | - | 9,785.6 | 9,785.6 | - | - |
| | TOTAL | 12,769.2 | 4,541,000 | 12,495.4 | 2,587,000 | 12,495.4 | 3,088,774 | 12,550.0 | 219.2 |

Appendix A (cont.) - Exceptional Design Compliance Calculations for all 16 Climate Zones

| END USE | BASELINE WATERSIDE ECONOMIZER | | BASELINE AIRSIDE ECONOMIZER (CURRENT MODEL) | | BASELINE AIRSIDE ECONOMIZER (MODIFIED DP CONTROL) | | LIEBERT® DSE™ SYSTEM PROPOSED DESIGN - CUSTOM CURVES | LIEBERT DSE SYSTEM COMPARISON (POSITIVE - FAVORABLE) | |
|-----------------|-------------------------------|------------------------|---|-------------------------|---|-------------------------|--|--|-------------------------------------|
| | TDV Btuh /FT² | EST. WATER USAGE GAL/Y | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh /FT² | TDV MARGIN VS. WATER ECON. | TDV MARGIN VS. AIR ECON. (MODIFIED) |
| CLIMATE ZONE 13 | Space Cooling | 1,464.9 | - | 1,029.7 | - | 1,029.7 | 2,299.9 | (835.0) | (1,270.3) |
| | Fans | 1,122.1 | - | 1,120.6 | - | 1,120.6 | 539.8 | 582.2 | 580.8 |
| | Lighting | 56.3 | - | 63.1 | - | 63.1 | 56.3 | - | 6.8 |
| | Pumps | 229.5 | - | 126.3 | - | 126.3 | - | 229.5 | 126.3 |
| | Heat Rejection | 83.7 | - | 81.5 | - | 81.5 | - | 83.7 | 81.5 |
| | Add for Low DP Control | - | - | - | - | 223.7 | - | - | 223.7 |
| | Compliance Total | 2,956.5 | - | 2,421.1 | - | 2,644.8 | 2,896.0 | 60.4 | (251.2) |
| | Interior Equipment | 9,781.4 | - | 9,781.4 | - | 9,781.4 | 9,781.4 | - | - |
| | TOTAL | 12,737.8 | 4,822,000 | 12,426.2 | 3,152,000 | 12,426.2 | 3,451,024 | 12,677.4 | 60.4 |
| CLIMATE ZONE 14 | Space Cooling | 1,457.3 | - | 1,073.3 | - | 1,073.3 | 2,404.3 | (947.0) | 1,331.0) |
| | Fans | 1,269.5 | - | 1,374.6 | - | 1,374.6 | 562.9 | 706.6 | 811.7 |
| | Lighting | 55.8 | - | 63.0 | - | 63.0 | 55.8 | - | 7.2 |
| | Pumps | 220.7 | - | 133.5 | - | 133.5 | - | 220.7 | 133.5 |
| | Heat Rejection | 57.3 | - | 58.5 | - | 58.5 | - | 57.3 | 58.5 |
| | Add for Low DP Control | - | - | - | - | 565.5 | - | - | 565.5 |
| | Compliance Total | 3,060.6 | - | 2,702.9 | - | 3,268.4 | 3,023.0 | 376 | 245.4 |
| | Interior Equipment | 9,774.9 | - | 9,774.9 | - | 9,774.9 | 9,774.9 | - | - |
| | TOTAL | 12,835.5 | 5,061,000 | 13,043.3 | 3,689,000 | 13,043.3 | 4,479,234 | 12,797.9 | 376 |

Appendix A (cont.) - Exceptional Design Compliance Calculations for all 16 Climate Zones

| END USE | BASELINE WATERSIDE ECONOMIZER | | BASELINE AIRSIDE ECONOMIZER (CURRENT MODEL) | | BASELINE AIRSIDE ECONOMIZER (MODIFIED DP CONTROL) | | LIEBERT® DSE™ SYSTEM PROPOSED DESIGN - CUSTOM CURVES | LIEBERT DSE SYSTEM COMPARISON (POSITIVE - FAVORABLE) | |
|-----------------|-------------------------------|------------------------|---|-------------------------|---|-------------------------|--|--|-------------------------------------|
| | TDV Btuh / FT² | EST. WATER USAGE GAL/Y | TDV kBtuh /FT² | EST. WATER USAGE GAL/YR | TDV kBtuh/ FT 2 | EST. WATER USAGE GAL/YR | TDV KBTUH /FT² | TDV MARGIN VS. WATER ECON. | TDV MARGIN VS. AIR ECON. (MODIFIED) |
| CLIMATE ZONE 15 | Space Cooling | 1,575.5 | - | 1,398.3 | - | 1,398.3 | 2,671.7 | (1,096.1) | (1,273.4) |
| | Fans | 1,003.9 | - | 1,060.6 | - | 1,060.6 | 527.1 | 476.8 | 533.5 |
| | Lighting | 55.8 | - | 62.9 | - | 62.9 | 55.8 | - | 7.0 |
| | Pumps | 219.5 | - | 167.5 | - | 167.5 | - | 219.5 | 167.5 |
| | Heat Rejection | 107.9 | - | 111.5 | - | 111.5 | - | 107.9 | 111.5 |
| | Add for Low DP Control | - | - | - | - | 395.6 | - | - | 395.6 |
| | Compliance Total | 2,962.7 | - | 2,800.8 | - | 3,196.4 | 3,254.6 | (291.9) | (58.2) |
| | Interior Equipment | 9,702.3 | - | 9,702.3 | - | 9,702.3 | 9,702.3 | (0.0) | (0.0) |
| | TOTAL | 12,665.0 | 5,551,000 | 12,898.7 | 4,779,000 | 12,898.7 | 5,469,519 | 12,956.9 | (291.9) |

| | | | | | | | | | |
|-----------------|------------------------|-----------------|------------------|-----------------|------------------|-----------------|------------------|-----------------|--------------|
| CLIMATE ZONE 16 | Space Cooling | 1,438.3 | - | 864.9 | - | 864.9 | 1,824.4 | (386.1) | (959.6) |
| | Fans | 1,311.4 | - | 1,272.0 | - | 1,272.0 | 591.1 | 720.3 | 680.9 |
| | Lighting | 56.3 | - | 63.1 | - | 63.1 | 56.3 | - | 6.9 |
| | Pumps | 223.4 | - | 111.8 | - | 111.8 | - | 223.4 | 111.8 |
| | Heat Rejection | 52.5 | - | 50.1 | - | 50.1 | - | 52.5 | 50.1 |
| | Add for Low DP Control | - | - | - | - | 866.9 | - | - | 866.9 |
| | Compliance Total | 3,081.9 | - | 2,361.9 | - | 3,228.8 | 2,471.7 | 610.1 | 757.0 |
| | Interior Equipment | 9,749.2 | - | 9,749.2 | - | 9,749.2 | 9,749.2 | (0.0) | (0.0) |
| | TOTAL | 12,831.0 | 4,154,000 | 12,978.0 | 2,188,000 | 12,978.0 | 3,013,134 | 12,221.0 | 610.1 |

BLUEPRINT

California Energy Commission
Efficiency Division



In This Issue

- » **Water and Energy Saving Economizer Approved**
- » **Lighting Acceptance Test Technician Certification Provider Certificates of Acceptance**
- » **Nonresidential Computer Compliance Program Updates**
 - **EnergyPro**
 - **Integrated Environmental Solutions**
- » **Energy Standards Presentations**
- » **Q&A**
 - **Radiant Floor Heating Panels**
 - **Signatures for Residential Compliance Documents**
- » **Energy Code Ace Training Schedule**

Water and Energy Saving Economizer Approved

During the September 9, 2015, Business Meeting, the California Energy Commission (Energy Commission) **approved** a new compliance option for economizers that save both water and energy. This approval allows pumped refrigerant based economizers to be used as an alternative to water-side economizers for com-

puter rooms (covered process), which are also commonly known as data centers. The benefit of using economizers is that they allow air conditioning systems to provide cool air to a space without operating the mechanical cooling system when outside temperatures are sufficiently cool. This results in energy savings.

Prescriptively, **Sections 140.9(a)1A and B** of the 2013 Building Energy Efficiency Standards (Energy Standards) require that mechanical cooling equipment serving a computer room be equipped with an air-side or water-side economizer. The approval to use pumped refrigerant economizers is an alternative to the use of water-side economizers per Section 140.9(a)1B, and is specific to pumped refrigerant economizers installed in climate zones 1-9, 11-14, and 16. This approval does not affect the use of air-side economizers per **Section 140.9(a)1A**.

Pumped refrigerant economizers bypass the compressor, and pump refrigerant through the evaporator and condenser. The difference in energy consumption between the pump and compressor is where the energy savings occur. In a scenario where a water-side economizer would otherwise be installed, this alternative has the added benefit of conserving California's water.

A pumped refrigerant economizer was **modeled and compared** to a water-side economizer serving a computer room for all 16 cli-

mate zones in California. The results showed the pumped refrigerant economizer system used less energy based on the time dependent valuation (TDV) for 14 of the 16 climate zones while using no water. An evaluation of computer room locations in California indicates most computer rooms are located within the 14 climate zones approved for the use of pumped refrigerant economizers. By switching from a water-side economizer to a pumped refrigerant economizer, roughly 4,000,000 gallons of water can be saved each year for a computer room with a load of 1.2 megawatts.

Lighting Acceptance Test Technician Certification Provider Certificates of Acceptance

Enforcement agencies should only see lighting control Certificates of Acceptance (NRCA-LTI-02-A, NRCA-LTI-03-A, NRCA-LTI-04-A, and NRCA-LTI-02-A) that have a logo from one of the following approved Acceptance Test Technician Certification Providers (ATTCs):

- » **California Advanced Lighting Controls Training Program (CALCTP)**
- » **National Lighting Contractors Association of America (NLCAA)**

Background

The goal of the ATTCP program is to provide training, certification, and oversight of technicians who perform the acceptance tests

STATE OF CALIFORNIA

Energy Resources Conservation
And Development Commission

Building Energy Efficiency Standards,
California Code of Regulations, Title 24,
Parts 1 and 6

Docket No. 15-MISC-03
Resolution No. 15-0909-10

**RESOLUTION OF THE ENERGY COMMISSION
APPROVING RECOMMENDATION BY THE EXECUTIVE DIRECTOR TO APPROVE
REFRIGERANT ECONOMIZERS AS AN ALTERNATIVE COMPONENT PACKAGE
FOR USE IN COMPUTER ROOMS IN CERTAIN CLIMATE ZONES**

WHEREAS, Section 25402.1(b) of the California Public Resources Code and Section 10-109(d) of Part 1 of Title 24 authorizes the Commission to approve compliance options and alternative component packages for demonstrating compliance with the Building Energy Efficiency Standards set forth in California Code of Regulations, Title 24, Part 6, and the associated administrative regulations in Part 1, Chapter 10; and

WHEREAS, Emerson Network Power submitted an application to the Energy Commission requesting that refrigerant economizers be approved as an alternative component package for demonstrating compliance with the prescriptive requirements set forth in Section 140.9(a)1B of Title 24, Part 6; and

WHEREAS, pursuant to Section 10-110(a) of Part 1 of Title 24 the Executive Director determined that the application for this alternative component package was complete, and staff of the Energy Commission made the application package available to interested parties for a 60 day comment period; and

WHEREAS, Energy staff prepared a report analyzing this alternate component package, which recommended that refrigerant economizers should be approved for use in computer rooms in climate zones 1-9, 11-14 and 16 as an alternative component package for demonstrating compliance with the prescriptive requirements set forth in Section 140.9(a)1B of Part 6 of Title 24; and

WHEREAS, based on the analysis and recommendation of staff, the Executive Director recommends that the California Energy Commission approve refrigerant economizers for use in computer rooms in climate zones 1-9, 11-14 and 16 as an alternative component package for demonstrating compliance with the prescriptive requirements in Section 140.9(a)1B of Part 6 of Title 24.

THEREFORE, the Energy Commission accepts the recommendation of the Executive Director and approves refrigerant economizers for use in computer rooms in climate zones 1-9, 11-14 and 16 as an alternative component package pursuant to Section 10-109 of Part 1 of Title 24, for demonstrating compliance with the prescriptive standard in Section 140.9(a)1B of Part 6 of Title 24, and directs the Executive Director to take, on behalf of the Energy Commission, all actions reasonably necessary to implement this resolution.

Date: September 9, 2015

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly approved at a meeting of the California Energy Commission held on September 9, 2015.

AYE: Weisenmiller, Douglas, McAllister, Scott

NAY: None

ABSENT: Hochschild

ABSTAIN: None



Tiffani Winter,
Secretariat

