Closed-Loop Water-Cooled Enclosure
GL840ES-3048-CLWCE

High Performance 30kW Closed-Loop Water-Cooled Enclosure

COOL THE SERVERS, NOT THE ROOM!

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COOL THE SERVERS, NOT THE ROOM!

Overcoming Data Center Challenges

The Great Lakes Closed-Loop Water-Cooling System, developed in conjunction with Naissus Thermal Management Solutions, addresses the primary challenge faced by data center managers today. As smaller, more powerful servers are compacted into higher density configurations, data center and air conditioning systems must expand to provide sufficient cooling air.

Even with costly floor space and air conditioning additions, data centers still struggle with uneven cooling and hot air recirculation resulting from heat exhaust traveling from other enclosures. The Great Lakes Closed-Loop Water-Cooled Enclosure (CLWCE) provides an integrated closed-loop cooling system, saves on floor space, power consumption and maintenance. It also seals servers from re-circulated exhaust, becoming a versatile high-density solution to today's data center challenges.

This enclosure is specifically designed to provide maximum, state-of-the-art data center cooling. Great Lakes offers a fully-configured enclosure (CLWCE) or a kit to convert any 42" or deeper ES Series enclosure from an air cooled unit to a water-based, liquid cooled unit. This allows the data center manager ultimate flexibility to upgrade to high density at any time.

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The CLWCE is a 36 rack mount unit (RMU), 19" EIA enclosure with an integrated closed loop cooling system. The CLWCE cooling system uses low pressure chilled water to remove the heat generated by the servers.

The CLWCE/Kit Includes:
An 8 RMU heat exchanger, developed in conjunction with Lytron Inc., an American company with over 50 years of experience in developing liquid cooling systems. Also included in the kit is a custom control unit to manage and monitor the system's two doors, fans in the rear door and a plenum in the front door to deliver conditioned air to the front intake of rack mounted servers.

Maximizing "up time" and fault tolerance has been considered in all aspects of this liquid cooling system:

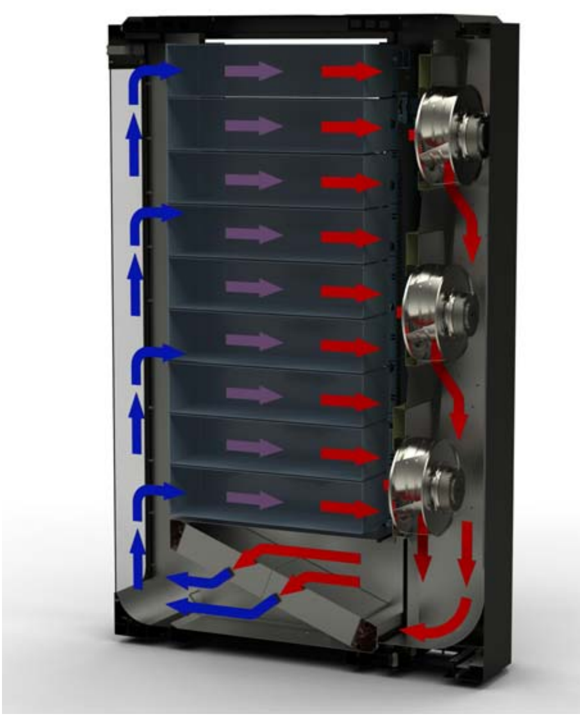
•The cabinet contains N+1 fans and a fan can be replaced while the system is running.

•If the temperature in the cabinet exceeds a user-defined threshold, the doors will automatically open, the fans will shut down, an alarm will be sent, and the system will use available room air to cool until the problem is resolved.

A Sustained Chilled Water Source:
• The CLWCE requires a consistent source of chilled water flowing at a specific rate. The optimum (and most cost effective) source is "tapping into" the return path of the water headed back to the chiller after supporting the data center's existing CRAC/CRAH units.

• A Coolant Distribution Unit (CDU) may also be used to ensure coolant is delivered at a consistent temperature and flow rate, typically set to a temperature above the dew point so the risk of condensation is eliminated.

• A liquid manifold is available. Pumping stations may also be installed to maintain flow rates over extended distances.



Cool air is delivered to the front of the cabinet. This air flows through the servers picking up heat, using the same concept as an open air cooled cabinet. However, instead of flowing out the back of the enclosure into the hot aisle, three fans located in the back door direct the hot air down to the bottom of the cabinet where it passes through a heat exchanger. The heat is transferred from the air to the coolant flowing through the heat exchanger. The temperature of air exiting the heat exchanger has been reduced and the air is now ready to begin the path again.

Closed-Loop Water-Cooled Enclosure

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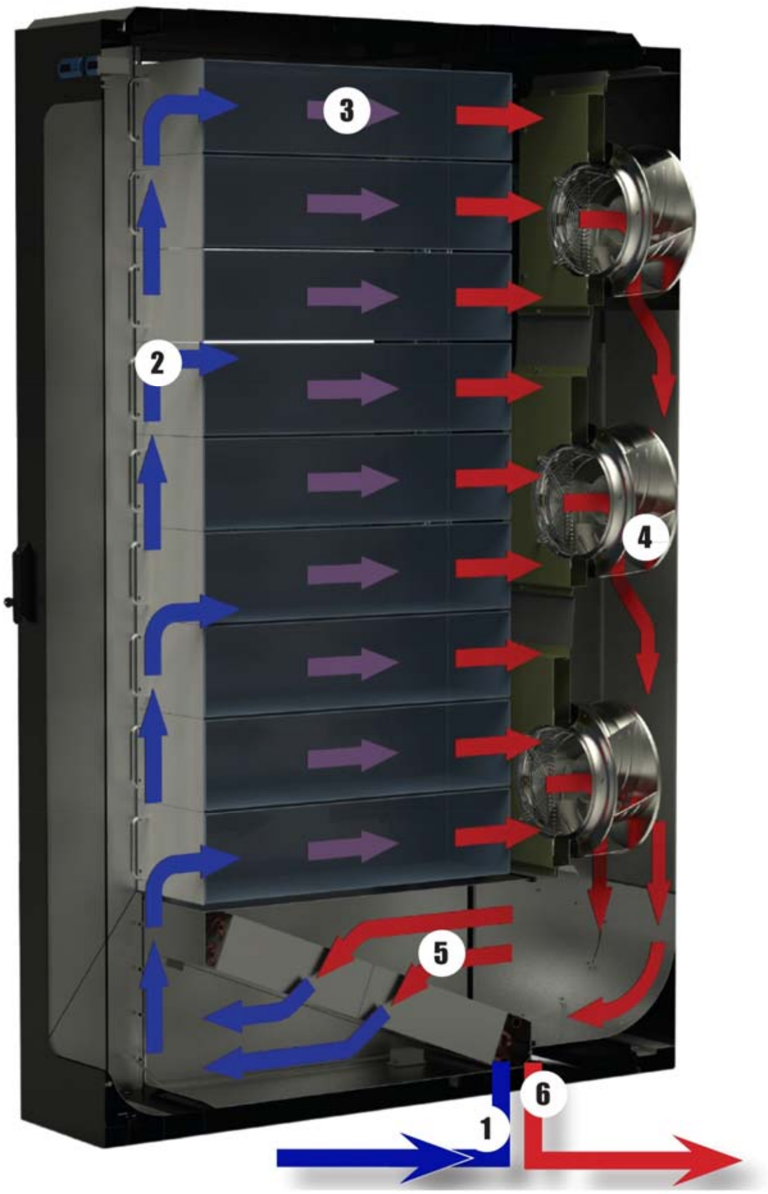

1. Chilled water arrives at the enclosure from a viable source or via a coolant distribution unit (CDU) to enter the heat exchanger.

2. Conditioned air at consistent pressure is directed through a plenum chamber.

3. Conditioned air passes through rack mounted equipment.

4. Quiet (65 dB) high efficiency variable speed exhaust fans remove hot air.

5. Hot air passes across the heat exchanger.

6. Water then leaves the heat exchanger coil to begin a return trip to the chiller or the CDU.

The Great Lakes CLWCE is the perfect infrastructure solution for retrofitting a high density enclosure solution into existing data centers. Created in response to escalating processor speeds and high thermal density created by clustered blade computing, the CLWCE helps to maximize space utilization while minimizing operating costs in high density applications.

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Performance

The Great Lakes Closed-Loop Water-Cooled Enclosure (CLWCE) is a unique closed-loop, water-chilled heat-transfer system.

• Eliminates the need for plenum (raised-floor) cooling systems

• Eliminates the need for hot and cold aisles

• Packs more equipment per square foot

• Limits the risk of overheating individual servers

• Provides uniform vertical cooling

• Increases flexibility; can be installed in various sites

• Reduces noise and maintenance

Security

• Laser-based incipient smoke detection

• FM 200 or Novec 1230 fire suppressants

• Environmental sensors

• 24/7 central or remote monitoring

• Thermostat-controlled, automatic door release

• Sealing gasket on the doors to protect against airborne particles

Efficiency

• Consumes 50% less floor space than plenum cooling

• Consumes up to 40% less energy than traditional infrastructure

• Provides a combined rack-mounting area of 36RU

• Uses a high-efficiency cooling core rated at 30kW

• Enables the highest density/ft^2 processing

• Enables optimized server performance

• Reduces system maintenance

With ever smaller and more powerful servers, today's data center managers struggle to improve PUE (Power Usage Effectiveness). Traditional Raised Floor Plenum Cooling systems tend to decline rapidly in efficiency, as thermal density increases.

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Description of Operation

The **CLWCE** is a net 36 Rack Mount Unit, 19” EIA enclosure system with an integral Closed-Loop Cooling System that relies on a supply of low pressure chilled water channeled through a high efficiency heat exchanger mounted in the base of the enclosure to act as a “sink” to absorb heat energy generated by servers and other related rack mounted equipment operating within the enclosure.

External chilled water feed and warm water return lines connect to the enclosure’s heat exchanger using flexible high pressure hydraulic hoses which attach using (standard) threaded ¾” brass male/female couplers .

When operational, warmed air is removed from the servers by a series of three independently controlled cooling fans installed within plenum chamber compartments in the rear door assembly.

The air is drawn through high capacity, variable speed EC, backward curved impeller fans and channeled through a duct assembly connecting the rear door assembly with the heat exchanger mounted in the bottom of the enclosure.

The on-board server fans pull the cooling air through the server chassis drawing waste heat out of the servers where it is collected by the fans, creating a continuous cooling loop.

The fans are variable speed and are operated by independent temperature controls allowing for greater economy of operation when the CLWCE system is not operating under a full load.

Front and rear doors are equipped with thermostatically controlled automatic release systems, designed to open, should a pre-set temperature condition within the enclosure be reached.

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Great Lakes Case & Cabinet is a leading manufacturer of high quality racks, wall mount and free standing enclosures, technical furniture and console systems for the data, communication, broadcast, and sound and security industries. With state of the art engineering and manufacturing capabilities, Great Lakes is unmatched in its ability to engineer and produce custom products to meet the specific needs of our customers around the world.

Our goal is to provide services, products and full turnkey solutions that reduce Total Cost of Ownership (TCO), increase data center efficiency and prepare operations for migration to high density computing in the era of "green data centers".

Great Lakes Case & Cabinet believes in a modular approach to data center design. Our scalable enclosure systems allow customers to utilize a wide variety of accessories compatible with our ES Series Enclosure, in the development and deployment of low to mid power solutions (8 – 12kW) that allows migration to a higher capacity (up to 30kW per enclosure) system to support increased server density. This is accomplished **without removing, repositioning or replacing the original enclosure frame**, therefore allowing users to maximize ROI by extending the life of data center assets and to reduce operating costs by greatly improving the data center's PUE.

We call it "Future-Proofing"

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Scalable "Low – Medium – High Density"

- A wide range of options are available, including power, monitoring, smoke detection and fire suppression.

- Great Lakes Closed-Loop Water-Cooled Enclosures are supplied as stand-alone units, in preconfigured high density modules or as custom designed and installed turn-key systems.

- Great Lakes offers one of the quietest "High Density" systems available (65dB vs. 85dB for most "In Row" - "Close Coupled" systems).

- The CLWCE consumes up to 40% less energy than conventional infrastructure.

- Requires 50% less floor space than plenum cooled systems.

- Removes up to 30kW of heat.

- Enables the highest density/ft² processing.

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The Great Lakes Closed-Loop Water-Cooled Enclosure improves PUE by cooling the equipment, not the room, thereby significantly reducing Data Center cooling costs. The CLWCE allows high concentration of Servers and other active computing devices. In most cases, the Closed-Loop Water-Cooled Enclosure will require (in excess of 50%) less floor space than plenum cooling.

Specifications
• Height: 2133.6 mm (84.0 in)
• Total Rack Height: 44RU (82.25 in)
• Usable height: 36RU (63.0 in)
• Depth: 1372.4 mm (54.0 in)
• Width: 762.0 mm (30.0 in)

Structural
• Empty weight: 850 lbs (385.55 kg)
• Shipping weight: 900 lbs (408.23 kg)
• Static load: 2000 lbs (907.18 kg)
• Four, 44RU EIA vertical mounting rails, numbered from 1 to 44 spaces

Front Door
• Non-reversible aluminum assembly combined with a full View-Thru™ Lexan® panel
• Electrical, spring-loaded auto door releases

Rear Door
• Non-reversible, aluminum door assembly
• Electrical, spring-loaded auto door releases
• Integral fan door/plenum duct

Top Panel
• Standard sealed top with brush cable entries

Side Panel
• 16 gauge cold-rolled steel
• Two lift handles per panel; Removable

Cooling Components- Rear-Mounted Fan Trays
• 3 Electric Commutated (EC) Backward Curved Impellers/Fans
• Operating Point 0 % at 20 degrees C; 100% at 40 degrees C
• 230VAC (200 – 270) Nominal voltage, 2.9A current draw
• Individual fan thermal speed control sensors (one per fan)

Heat Exchanger
• 8 – 16 gpm heat-exchange cooling core supplied with ¾-inch high-pressure hose and optional ¾” flange NFP connections

Optional Accessories

Multiple outlet PDUs

Smoke detection/fire suppression

- Fully integrated FM200 system or 3M Novec1230 system
- Automatic-release primary gas cylinder
- VESDA laser smoke detector

24/7 fully integrated monitoring package available for

- Server inlet air temperature
- Server outlet air temperature
- Humidity
- Smoke/fire detection
- Water-leak detection
- Door-open alarm
- Fans and power supplies

Performance Based on Lab Server Tests

		Imperial Units	Si Units
Inputs	Heat Load	102500BTU/h	30.0 kW
	Water Temp.	55° F	12.7° C
	Water Flow	14 gpm	.88 l/s
Results	Cold Air Supply	73° F	23.0° C
	Hot Air Return	109° F	42.8° C
	Air ΔT	35.7° F	19.8° C
	Water Temp. Rise	13.7° F	7.6° C
	Water Pressure Drop	10 psi	48.3 kPa
Background	Air Flow	2500 CFM	1.18 m3/s
	Fan Power	2278 BTU/h	667.0 W

Source: Naissus Thermal Management Solutions Inc.

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A CLWCE Case Study - ENBRIDGE

Enbridge Inc., a Canadian company, is a North American leader in delivering energy and one of the Global 100 Most Sustainable Corporations.

Overview – Introduction of High Density Hardware in a Low Density Data Center

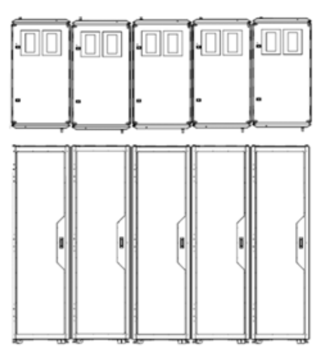
- Corporate Mandate to reduce electrical consumption and "green up" all IT facilities
- IT department retiring 80 leased, 2U Servers and replacing them with 3 High Density Blades
- 40 year old facility - Originally 25w/sq ft - 50% @ 9"Raised Floor - 50% @ 18" Raised Floor
- No overhead clearance - No way to expand perimeter - Can't move - Won't outsource

Infrastructure Options Considered and then Abandoned:

- **Additional CRAC Units – insufficiently sized plenum floor, couldn't move enough air**
- **In-Row Cooling –disruptive: requires reconfiguring rows, also impractical and inefficient**

The Situation

- *80 Legacy Servers (1RU and 2RU) in 5 Racks / Rack Loading at 5.6kW each or 28kW*
- Room Cooling: Small Plenum >1' with Supplemental Ambient Air via CRAHs
- Ambient Air Temp: 66 – 72°F
- Space Allocation: 39.6ft^2
- Power Usage Effectiveness: 2.0
- Cost $ per kW Hour: 0.10
- Annual cost to operate: $49,600
- Acoustic Noise - Operating point: 85dB



The Solution

- **Those 5 enclosures can be replaced with a single GL840ES-3048-CLWCE**
- **Those 80 Servers can be replaced with 3 Blade Servers at 9.3kW each or 28kW total**
- **Space Allocation: 11.25ft^2**
- **Net Gain in Real Estate: 28.35ft^2 or 71.5%**
- **Power Usage Effectiveness: 1.2**
- **Power Cost $ per kW Hour: 0.10**
- **Annual cost to operate: $34,339**
- **Annual net saving in energy: $21,071**
- **Five years net savings in energy: $105,356**
- **Acoustic Noise - Operating point: 65dB**

The Installation

Every data center is different and therefore there is no "one size fits all" approach to enclosure cooling and the removal of heated exhaust. In this case study, Enbridge was introducing new, emerging technology into an aging, legacy data center. Since the goal was to be green and cost effective, it did not make sense to bring in an independent source of chilled water and a cooling distribution unit (CDU) which might be found in a "greenfield" site, dedicated to closed-loop water cooling.

The available resources were studied and temperatures were studied for the water leaving from and returning to the CRAC system chiller. With a temperature of 55° F, the water which came from the return pathway for the CRAC system's chiller provided a perfect source to feed the CLWCE.

- Enbridge was able to tap into the 2" copper return line, branched from the main return line running from the CRAC. A pumping station was created to maintain adequate flow to the enclosure, created from "off-the-shelf" components, to deliver a sustained flow rate of 10 gallons per minute.

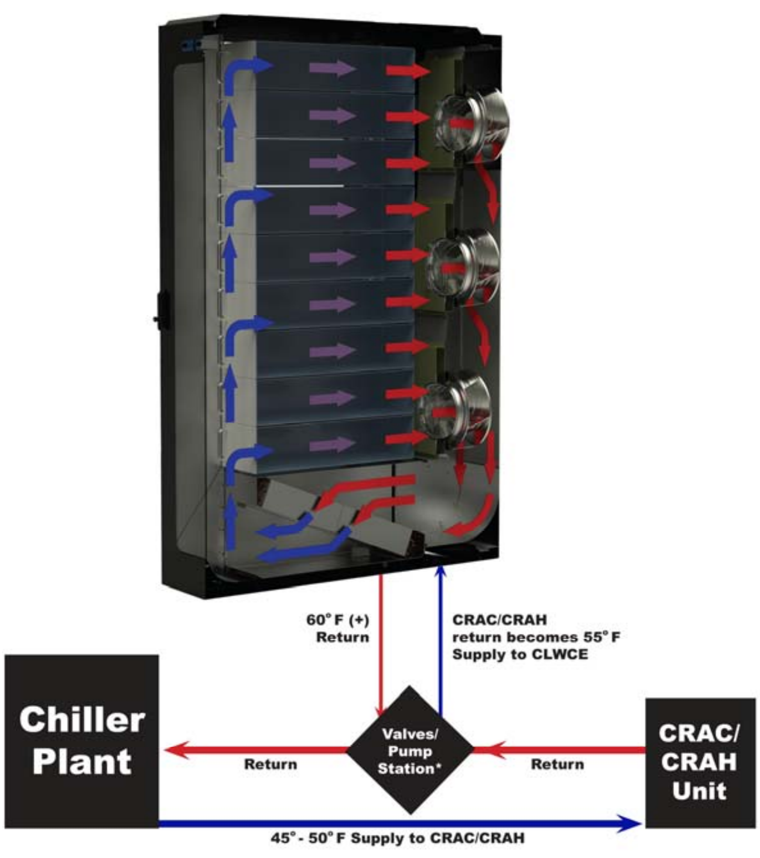
- After passing through the CLWCE's heat exchanger, the water flows out of the enclosure and continues its return path to the chiller.

It is important to note that Enbridge experienced an added benefit; a 20% increase in CRAC system efficiency which contributed to an additional "delta" increase in return water temperature after supporting both the CRAC and the CLWCE.

- Based on environmental conditions within the data center, the water temperatures entering the CLWCE heat exchanger may vary, but the enclosure's variable speed fans are designed to easily handle and accommodate for those variances.
- The enclosure at Enbridge has been in operation for nearly 18 months and humidity within the enclosure has not altered more than 4-5 percent. The average relative humidity is between 29 and 34 percent, which mirrors the conditions found in the data center itself.
- There has never been an issue with leakage or condensation. The CLWCE at Enbridge operates at 1.2 PUE using the free, recycled water.

This solution met all of Enbridge's corporate mandates and exceeded the "green" expectations of management:

- Introduced new technology to an aged facility
- Allowed new, high density servers to function without the adding CRAC capacity
- Reduced the amount of data center floor space used for the same processing capability of servers
- Incorporated use of recycled water from the CRAC to chiller return line by passing it through the CLWCE's heat exchanger, raising the temperature of the water further before return to the chiller, increasing system efficiency.



*Every data center is different. A pump station may be necessary, based on system pressure, distances to be traveled and the number of CLWCEs to be supported.

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The CLWCE has easy to read enclosure diagnostic indicators.

The pump station is shown in the floor of the data center space, helping to deliver water returning from the CRAC / CRAH units to the CLWCE to become its' cold water supply.

Bottom rear view of the CLWCE, showing the heat exchanger connections.

The rear door of the CLWCE and its' three, vanaxial fans, which remove/channel the heated exhaust from servers into the enclosure's rear plenum chamber. The fans and chamber drive the exhaust across the heat exchanger where the heat is extracted, creating the conditioned air to be delivered to the plenum chamber in the front of the enclosure and the front intake of the servers mounted within.

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The Great Lakes CLWCE = Significantly Lower Annual Operating Costs

Calculating Energy Savings based on PUE Improvements

(Data provided courtesy of Naissus Thermal Management Solutions)

Current Efficiency Level, IT Load, & Energy Costs		
	PUE	**DCiE**
Enter Current PUE	2.00	50%
Energy consumed per hour	kW	MW
Enter Current Total IT Load	150	0.15
Current Total Facility Load	300	0.30
	Cost (kWh)	
Enter Electricity Cost	$0.13	
	kW	MW
Current Power used per Year	2,628,000	2628
Current Annual Power Cost	$341,640	

PUE Goal

1.25

Enter Desired PUE Goal above

Annual Savings in Energy Costs for Desired Efficiency		
	PUE	**DCiE**
Improved Benchmarks	1.25	80%
Energy consumed per hour	kW	MW
Total IT Load	150	0.15
Improved Total Facility Load	187.5	0.19
	Cost (kWh)	
Estimated Electricity Cost	$0.13	
	kW	MW
Improved Power used per Year	1,642,500	1643
Improved Annual Power Cost	$213,525	

Annual Energy Savings

$128,115
985,500 kW
38%

U.S. State	Cost per kWh	Current Annual Energy Costs 2.00 PUE	Revised Annual Energy Costs 1.2 PUE	Annual Energy Savings
Alabama	$0.09	$236,520	$147,825	$88,695
Alaska	$0.15	$394,200	$246,375	$147,825
Arizona	$0.09	$236,520	$147,825	$88,695
Arkansas	$0.08	$210,240	$131,400	$78,840
California	$0.13	$341,640	$213,525	$128,115
Colorado	$0.09	$236,520	$147,825	$88,695
Connecticut	$0.17	$446,760	$279,225	$167,535
Delaware	$0.12	$315,360	$197,100	$118,260
District of Columbia	$0.13	$341,640	$213,525	$128,115
Florida	$0.11	$289,080	$180,675	$108,405
Georgia	$0.09	$236,520	$147,825	$88,695
Hawaii	$0.29	$762,120	$476,325	$285,795
Idaho	$0.06	$157,680	$98,550	$59,130
Illinois	$0.09	$236,520	$147,825	$88,695
Indiana	$0.07	$183,960	$114,975	$68,985
Iowa	$0.07	$183,960	$114,975	$68,985
Kansas	$0.08	$210,240	$131,400	$78,840
Kentucky	$0.06	$157,680	$98,550	$59,130
Louisiana	$0.09	$236,520	$147,825	$88,695
Maine	$0.14	$367,920	$229,950	$137,970
Maryland	$0.13	$341,640	$213,525	$128,115
Massachusetts	$0.16	$420,480	$262,800	$157,680
Michigan	$0.09	$236,520	$147,825	$88,695
Minnesota	$0.08	$210,240	$131,400	$78,840
Mississippi	$0.09	$236,520	$147,825	$88,695
Missouri	$0.07	$183,960	$114,975	$68,985
Montana	$0.07	$183,960	$114,975	$68,985
Nebraska	$0.07	$183,960	$114,975	$68,985
Nevada	$0.10	$262,800	$164,250	$98,550
New Hampshire	$0.15	$394,200	$246,375	$147,825
New Jersey	$0.15	$394,200	$246,375	$147,825
New Mexico	$0.08	$210,240	$131,400	$78,840
New York	$0.17	$446,760	$279,225	$167,535
North Carolina	$0.08	$210,240	$131,400	$78,840
North Dakota	$0.07	$183,960	$114,975	$68,985
Ohio	$0.08	$210,240	$131,400	$78,840
Oklahoma	$0.08	$210,240	$131,400	$78,840
Oregon	$0.07	$183,960	$114,975	$68,985
Pennsylvania	$0.09	$236,520	$147,825	$88,695
Rhode Island	$0.16	$420,480	$262,800	$157,680
South Carolina	$0.08	$210,240	$131,400	$78,840
South Dakota	$0.07	$183,960	$114,975	$68,985
Tennessee	$0.08	$210,240	$131,400	$78,840
Texas	$0.11	$289,080	$180,675	$108,405
Utah	$0.07	$183,960	$114,975	$68,985
Vermont	$0.12	$315,360	$197,100	$118,260
Virginia	$0.08	$210,240	$131,400	$78,840
Washington	$0.07	$183,960	$114,975	$68,985
West Virginia	$0.06	$157,680	$98,550	$59,130
Wisconsin	$0.09	$236,520	$147,825	$88,695
Wyoming	$0.06	$157,680	$98,550	$59,130
U.S. Total Average	$0.10	$264,346	$165,216	$99,130

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For more information on the Great Lakes Closed-Loop Water-Cooled Enclosure or any of our other products, please call 1-866-TRY-GLCC (1-866-879-4522)

You can also visit us on the web at www.werackyourworld.com

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