



An Environmentally Sustainable Datacenter With Immersion Cooling

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IEEE Life Member**



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About Engineered Fluids, Inc.

- **Engineered Fluids, Inc. is a private company headquartered in the USA**
 - Headquarters, system development and prototype lab in St. Petersburg, FL
 - Chemical manufacturing and distribution facility in Tyler, TX
- **Genesis:**
 - Dr. David Sundin – Founder, Chief Scientist – 40yrs experience in development, manufacture, and applications of Dielectric Thermal Transfer Fluids
 - Gary Testa – Founder, President & CEO – serial entrepreneur with 30yrs experience in global sales, marketing, product management & development in mobility, telecom, cloud and software
 - David and Gary founded Engineered Fluids in 2017 to bring to market the Dielectric Coolants that David had spent 7 years perfecting for electronics cooling applications
- **Engineered Fluids Today**
 - Production Capability: 750k Liters weekly (single shift) via a fully automated production line
 - Customers: over 6,500 customers in more than 80 countries
 - Hundreds of Thousands of electrical devices immersed in our coolant products
 - Distribution:
 - EU / UK Distribution from own warehouse in Amsterdam, NL
 - Global Distribution & JV Partners: Australia, China/HK, Egypt, Israel, South Africa, and Taiwan.

About Engineered Fluids, Inc.

Specialized developer of Single-phase Liquid Immersion Cooling Solutions

High-Performance Biodegradable, Non-Toxic, Non-Corrosive Dielectric Coolants

ElectroCool® - Dielectric Immersion Coolants for Semiconductors and Servers

- Server / CPU / GPU / SSD / DRAM
- Lasers / LEDs / RF Amplifiers / Tubes / Processors / RADAR
- Battery / Fuel Cell cooling for Power Generation (Solar / Wind / Conventional) in stationary electrical storage applications

AmpCool® - Dielectric Immersion Coolants for Batteries, Electric Motors and Hydraulics

- Electric motors & motor controllers
- Contains Extra Lubricity for Bearing Lubrication
- Hydraulic power transmission and actuator systems
- Battery and Fuel Cell cooling in hybrid and electric vehicles
- High Voltage Battery / Fuel Cell cooling in specialty and stationary electrical storage applications

SubmergeDeep® - Pressure Compensating Dielectric Immersion Coolants for Submarine Applications

- AUVs and Robotics
- Hydraulic power transmission
- Aquatic applications for pressure compensating, insulating, and lubrication

What is **SLIC** Technology?

SLIC : *Single-phase, Liquid Immersion Cooling*

The full immersion of electrical devices directly into single-phase dielectric heat transfer fluid that is either passively circulated by the natural convection of the heated coolant or actively circulated by pumping the dielectric coolant through and around the electrical device being cooled.

Single-phase

- A single-phase coolant does not boil or undergo a phase change at anytime during the cooling process. This eliminates all pressure, fumes, vapors, and corrosion due to micro-cavitation created by a coolant's state transition from liquid to gas.

Liquid

- The coolant is a Newtonian fluid and can be circulated and transported within the system at very low pressure and low flow rates using standard inexpensive hoses, pipes, pumps, and cooled with radiators, dry coolers, or heat exchangers.

Immersion

- Direct immersion of electronics in a non-electrically conductive (dielectric) engineered coolant such that no protective cover, enclosure, coatings, or other means of insulation is required to be applied to the electrical circuits, chips, or device.

Cooling

- The removal of thermal energy from a device through absorption by a dielectric coolant and transfer to a heat rejection device or heat reuse appliance through the circulation of the coolant without the use of compressors or phase change.

SLIC is simply the most efficient and cost-effective means to cool all high-power electronics.

Single-phase, Liquid Immersion Cooling

With the right coolant fluid, you can immerse and cool any electrical device. Here's a tube-type audio amplifier that's been immersed in ElectroCool Coolant for over five years!



Why **SLIC** Technology?

SLIC : *Single-phase, Liquid Immersion Cooling*

*Immersion Cooling Technology is **efficient!***

2000 Times more efficient than air!

- *Enables Huge Cost Savings for users!*
- *Enables Huge Demand Reduction for Energy Providers!*
- *Enables cooling where it wasn't possible before!*

SLIC Technology Cuts Water Use!

SLIC Technology Enables Heat Reuse, the Ultimate in Cooling Efficiency



SLIC for Data Centers:

Cost Savings and Energy Reuse

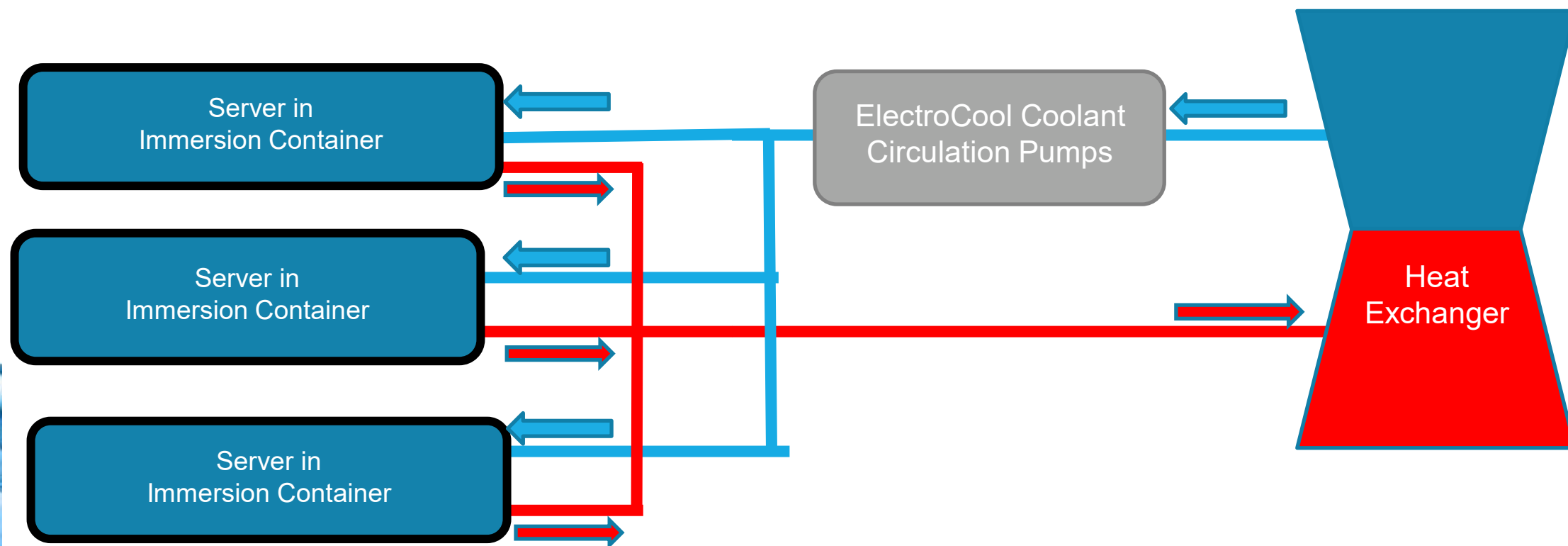


Typical Liquid Immersion Cooling Infrastructure

Immersion Container

Coolant Pumps

Heat Reuse



Immersion Cooling in Data Centers

Open Tank Design:

Servers are fully immersed in dielectric liquid coolant in a tank. Servers are cooled by low pressure circulation of coolant around servers, moving the heat outside where it's reused.

No fans required! A low volume, low pressure flow of ElectroCool through standard air-cooled servers placed in tanks

Uses all standard connectors, including optical connectors.

Open bath cooling with no vapors, no smell, no fans, no noise, and no problems!



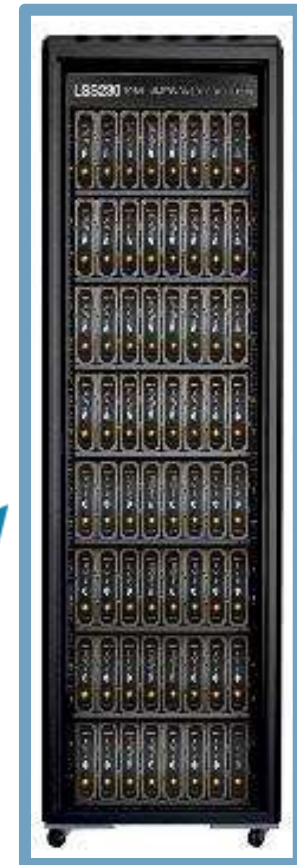
Here's what Liquid Immersion Cooling looks like: "Cassette Model"

Individual servers are mounted inside airtight containers, which are flooded with dielectric liquid coolant. Cassettes are mounted in racks and plumbed together and to pumps.



Individual servers are installed inside their own enclosures, connected together and filled with coolant

Cassette containers are mounted inside standard server racks



Here's what Liquid Immersion Cooling looks like:

“Cassettes” in Racks



Open Tanks



Data Center Energy Savings with SLIC

Data Centers use a lot of energy, according to US DOE.

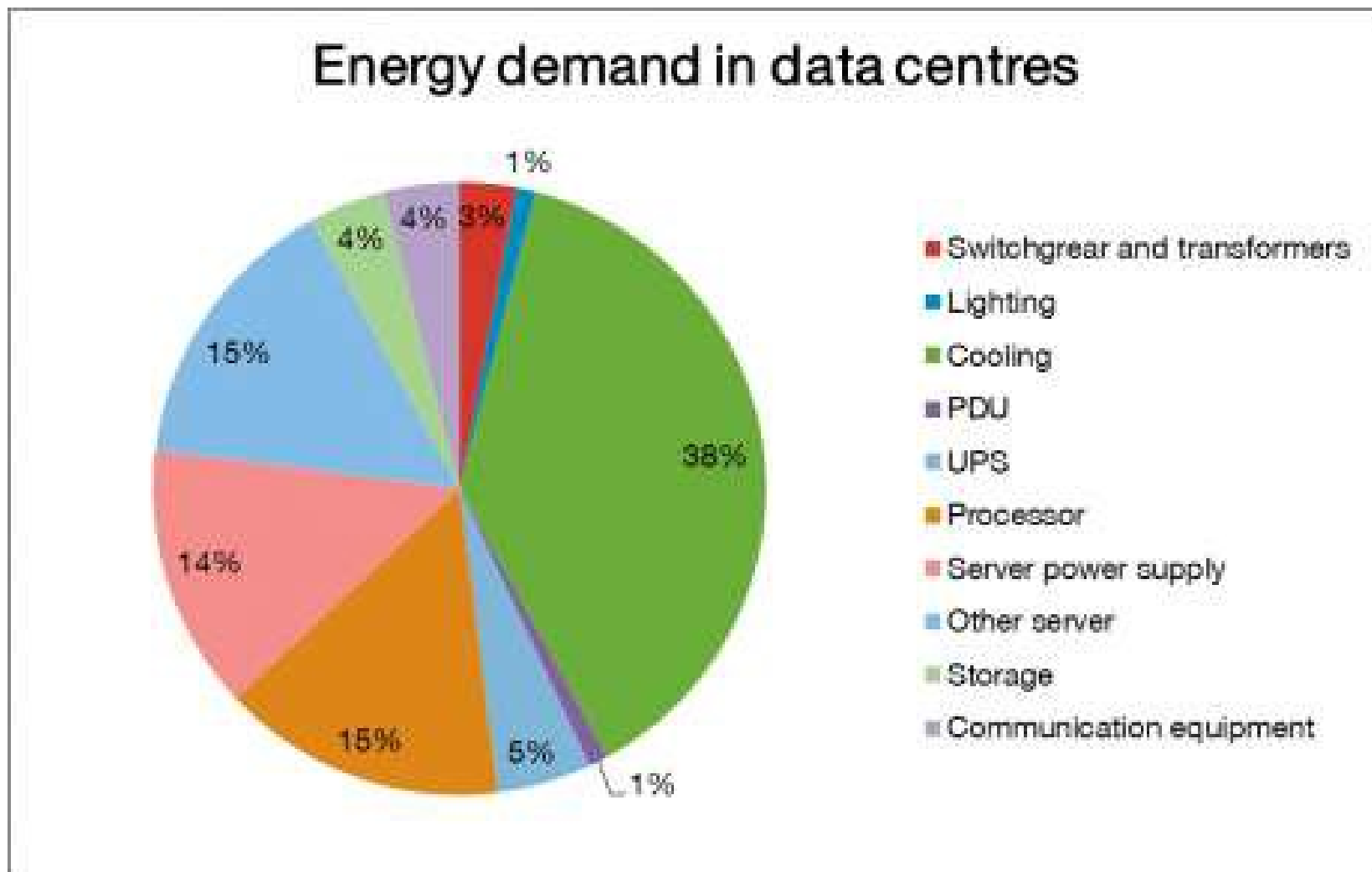
“Based on current trend estimates, U.S. data centers are projected to consume approximately 4193 billion kWh in 2025”

Wholesale power costs for datacenters in the US
average \$0.05/kWh

Annual Cost of US Data Center Power = **\$209 Billion**

How is All That Power Used?

Doing the “Thinking”? NO! It’s COOLING the Data Center!

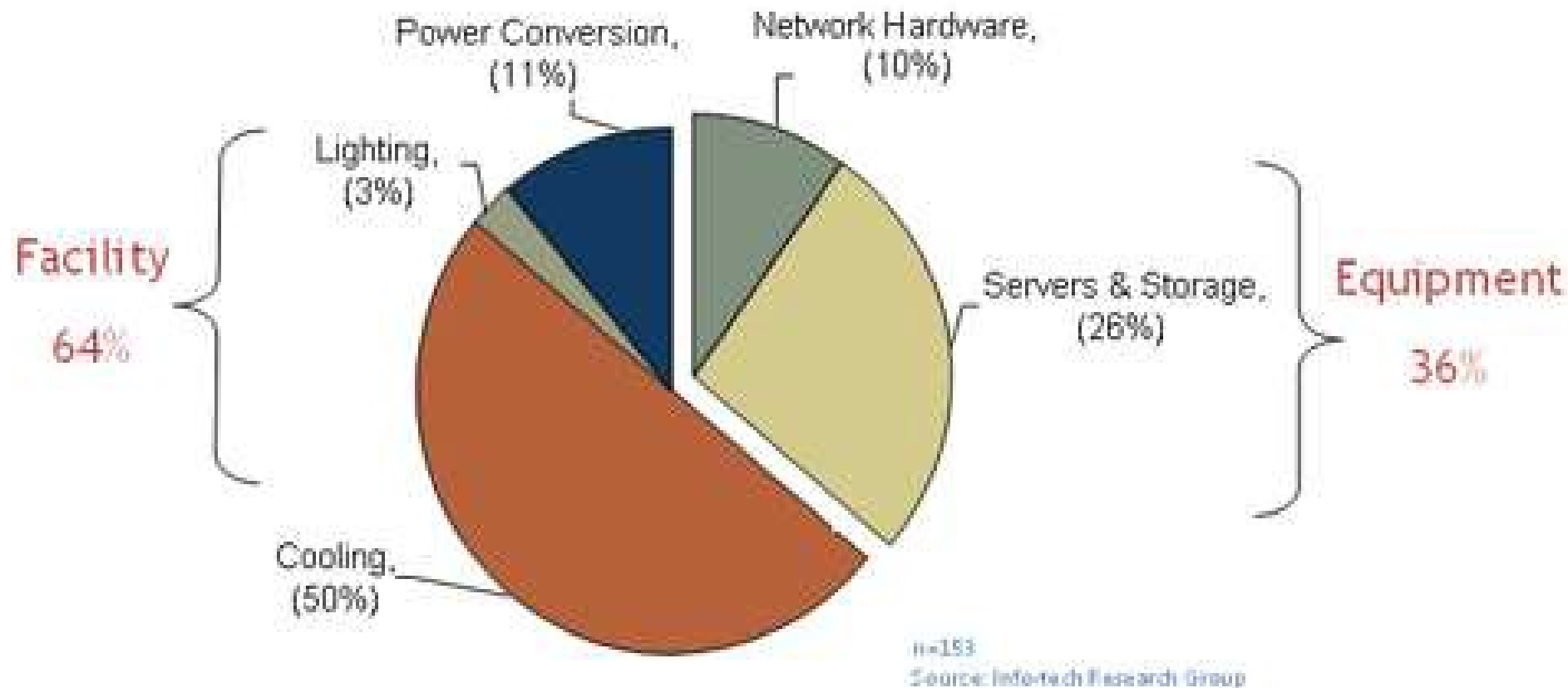


Source: ibusinessedge.com

How is All That Power Used?

Another View:

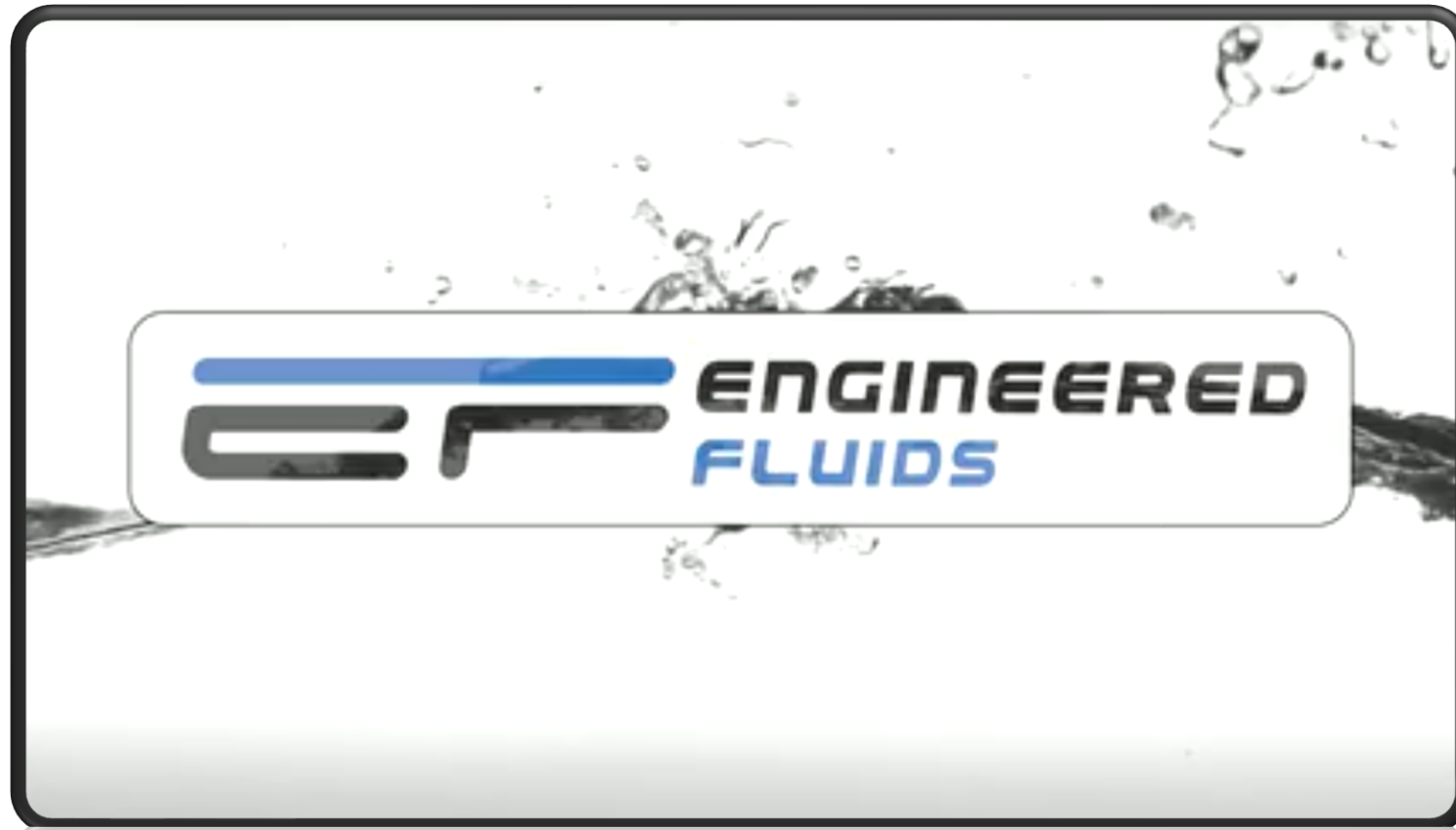
Typical Data Center Energy Consumption



How Much Cooling Costs Can Be Saved?

Listen to the Customers:

Chris Laguna says “We’re cutting about 90% of our energy costs with Immersion Cooling”



Data Center Energy Savings with Immersion Cooling

*Annual Cost of US Data Center Power = **\$209B/yr***

40% of Today's Data Center Power is for Cooling:

40% x \$209B = \$83B/yr in Cooling Costs

SLIC Thermal Management can save 90% of that:
\$74B per year in the US alone.

That's a 36% Operating Cost Reduction

The Future: What's the Trend

Servers will get hotter and faster

- *GPUs are dramatically accelerating this trend along with AI, IoT, etc.*

Space will be premium

- *Data center locations will increasingly be close to the edge*

Power costs will increase

- *Driven by high speed machines, natural resource and environmental concerns*

Data Center Heat Reuse – The Key to Sustainability!

*Immersion Cooling Produces High Quality Heat Energy at 60-65C,
with high heat capacity*

*Heat is easily moved to heat greenhouses, buildings, hot water systems,
office flooring, fish farms, de-icing sidewalks.*

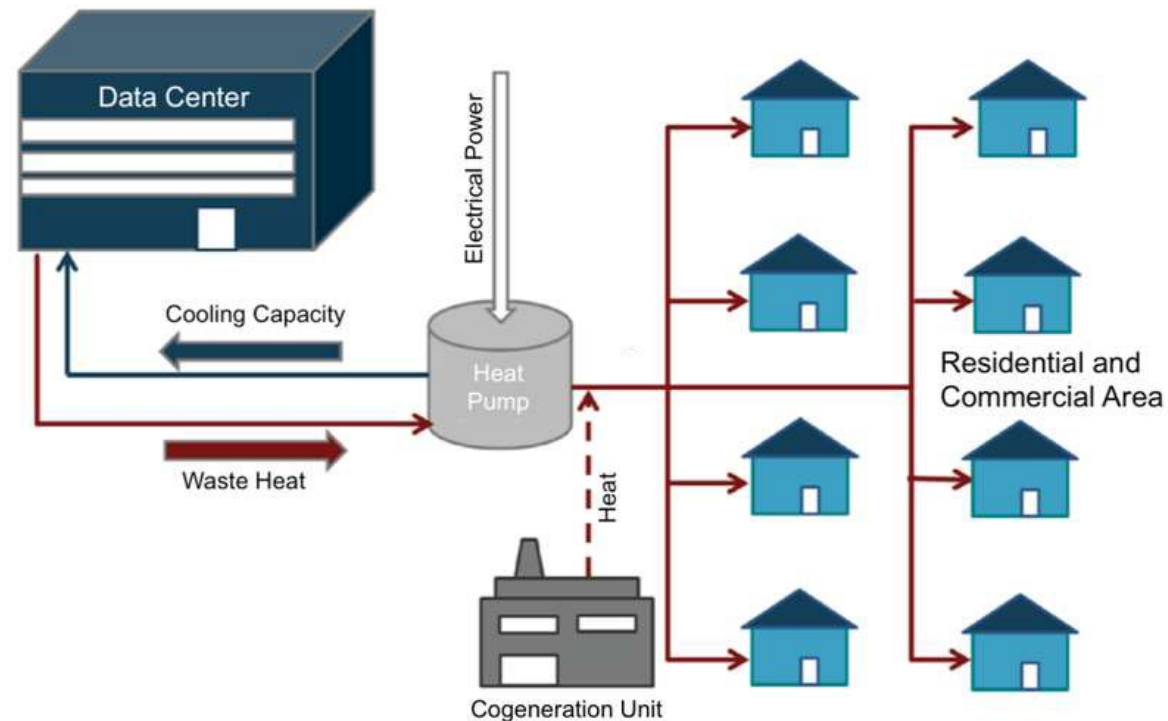


Image: NeRZ

Data Center Heat Reuse

Greenhouse array in Vancouver, BC, heated by 51MW Data Center, immersion cooled with ElectroCool Coolant:



Other Benefits of Immersion Cooling

Service Life Extension

- *Remove Fans*
- *Remove Fan Vibration*
- *No Temperature Excursion*
- *No corrosion, dust, pollution, acid buildup*
- *Reduction in CO2 emissions by Data Centers*



ElectroCool[®] Dielectric Coolants

ElectroCool Dielectric Coolants are the highest performance biodegradable, non-toxic dielectric thermal management fluids available.

Download Information on ElectroCool:



Product ID	EC-100	EC-110	EC-120	EC-130	EC-140
Typical Application	General electronics cooling with excellent material compatibility	Outdoor and sealed system electronics cooling and insulation	Enterprise grade cooling of servers, semiconductors, and electronics	Data center cooling of servers, GPUs, semiconductors, and electronics	High temperature semiconductor & electronics cooling and insulation
Fluid Behavior	Non-Compressible, Isotropic, Newtonian				
Appearance	Clear				
Dielectric Strength	>60kV				
Resistivity (ohm-cm)	>1x10 ¹⁴				
Dielectric Constant	2.3	2.3	2.1	2.2	2.3
Refractive Index n _D ²⁰	1.462	1.440	1.442	1.453	1.465
Pour Point (°C)	-55	-57	-66	-57	-54
Flash Point (°C)	180	150	157	135	280
Density, g/cc @ 15.6°C	0.8133	0.7980	0.7980	0.8244	0.9300
Coefficient of Thermal Expansion, volume/°C	0.00068	0.00068	.00067	0.00066	0.00070
Kinematic Viscosity (cSt)	0°C 47.12 40°C 9.58 100°C 2.68	0°C 27.43 40°C 6.43 100°C 2.00	0°C 18.99 40°C 5.02 100°C 1.70	0°C 12.12 40°C 3.72 100°C 1.41	0°C 794.61 40°C 66.46 100°C 9.53
Thermal Conductivity (W/m*K)	0°C 0.1396 40°C 0.1373 100°C 0.1339	0°C 0.1382 40°C 0.1359 100°C 0.1325	0°C 0.1383 40°C 0.1359 100°C 0.1325	0°C 0.1404 40°C 0.1374 100°C 0.1329	0°C 0.1601 40°C 0.1584 100°C 0.1561
Specific Heat (J/g*K)	0°C 2.0540 40°C 2.2032 100°C 2.4270	0°C 2.0608 40°C 2.2121 100°C 2.4388	0°C 2.0608 40°C 2.2121 100°C 2.4390	0°C 2.0577 40°C 2.2090 100°C 2.4355	0°C 2.0460 40°C 2.1912 100°C 2.4090
Global Warming Potential	0	0	0	0	0
Biodegradability (28 Days)	>93%	>96%	>96%	>98%	>50%
Materials Compatibility Warranty	Yes	Yes	Yes	Yes	Yes
Product Operational Warranties (Yrs) ¹	0, 5, 10	0, 5, 10	0, 5, 10	0, 5, 10	0, 5, 10
Shelf Life (Yrs) ²	5	5	5	5	5



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