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PUE 0.7, Data Center of the Future?

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Data Center Dimensions

Today's Convergence

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Sustainability

- **Facebook commitment to reduce greenhouse gas footprint by 75%**
- **Microsoft commitment to cut carbon emissions by 10 million metric tons by 2030**
- **LEED Designs (Leadership in Energy and Environmental Design)**

Internet of Things (IOT)

- Edge Data Centers, Remote Data Collection and Processing, 5G Rollout

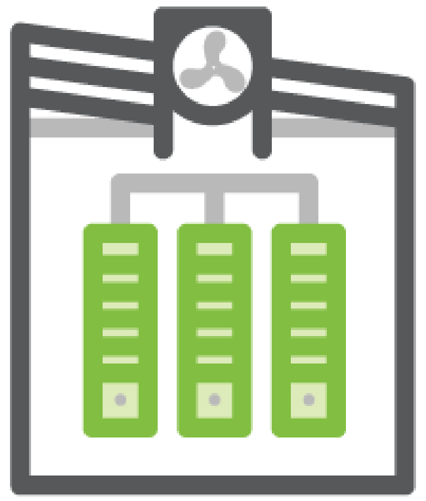
Technology

- Liquid Cooling, Very Low PUE
- Advanced Modular Solutions

Cloud and Colocation Solutions

- Public
- Private
- Hybrid

Data Center Heat Recovery



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Technology Exists for Practical Heat Recovery

- LiquidCool (Dielectric Fluid Solutions)
- Cloud & Heat Technologies (Water Based Solutions)

Liquid Cooling Much More Efficient than Air

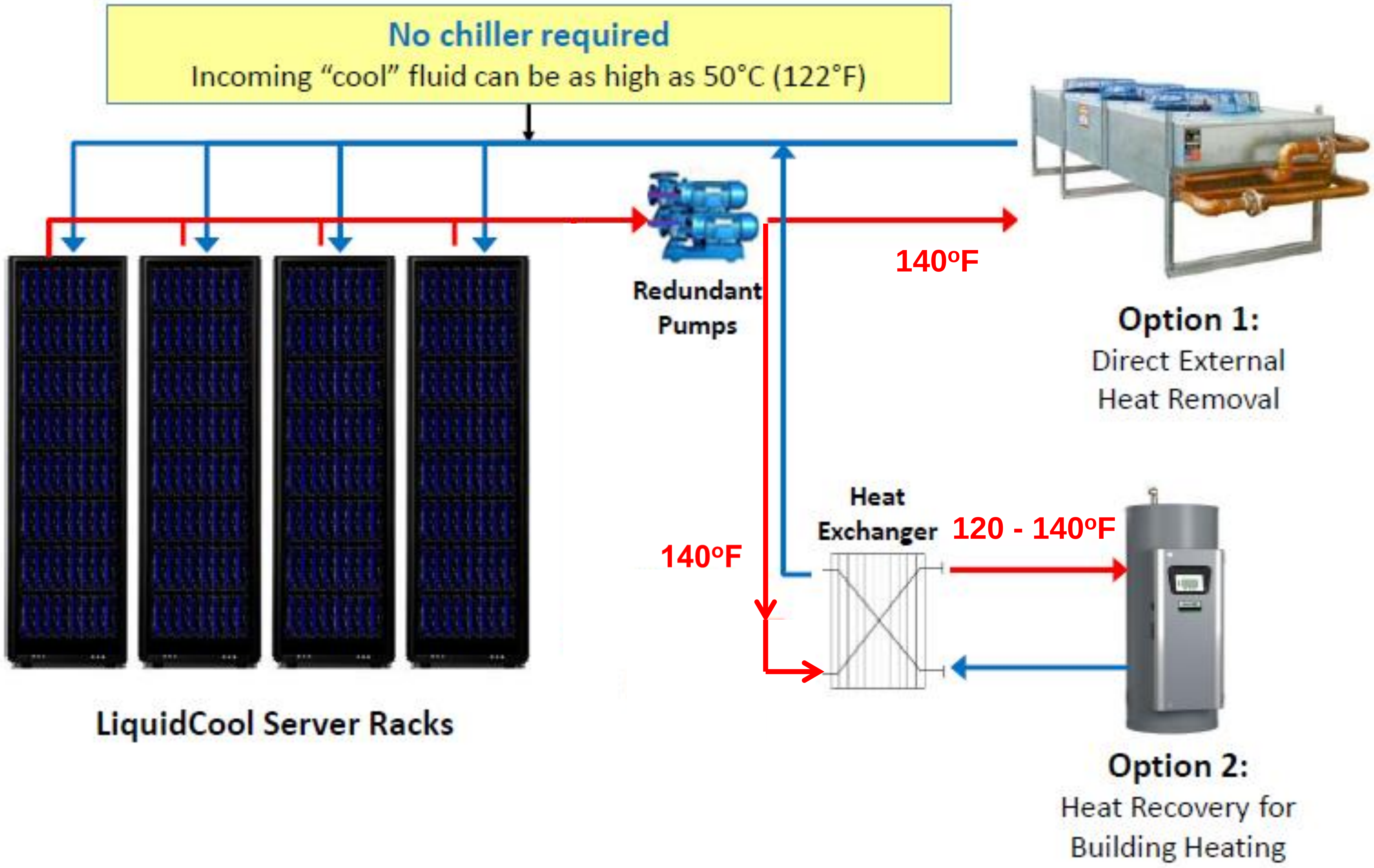
- Dielectric Fluid Options
- Water Options

Technology Tested and Operational at 140ºF (60ºC) Exiting Temperatures From Server

Older Buildings Typically Use 180ºF (82ºC) Water for Heating

New Construction Buildings Typically Use 120ºF – 140ºF (49ºC – 60ºC) Water for Heating (Condensing Boiler Technology)

Data Center Heat Recovery



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Data Center Heat Recovery

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Suggested Heat Recovery Adjusted PUE Calculation

$$\frac{\text{(Total Facility Power – BTU Heat Recovered/3.412)}}{\text{Total IT Power}}$$

Data Center Heat Recovery Simplicity

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Hardware Technology

Liquid Cooling Server Technology Already Exists with Multiple Vendors
Longer Lasting IT Hardware, No Exposure to Dust and Environment

Mechanical

Very Few Moving Parts – Fluid Pumps and Drycooler Fans, Very Easy for Spare Parts
No Compressors, No Chillers, No CRACs, No Airflow Issues

Electrical

Consider UPS Options which function up to 100°F
EcoMode UPS Options for 99% UPS efficiency

Water

No Water Usage other than Potential Closed Loops

Data Center Heat Recovery

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In a survey of 55,000 schools In the USA…

1. **…that have a median size of 75,000 ft^2,**
2. **…And an Annual Median Fuel Consumption of 114,000 BTU/ft^2,**
3. **…Where 92% of Fuel Consumption goes to Building Heat and Hot Water (78,660 therms/year),**
4. **…Contributing 417 metric tons of CO2 per year per School,**
5. **…Meaning 55,000 Schools Contribute 22,935,000 Metric tons CO2 Every Year**
6. **…There are approximately 132,000 public and private schools in the USA**
7. **…An Estimated 1000-2000 New Schools are Built Each Year**
8. **Microsoft wants to cut 10,000,000 metric tons CO2 by 2030, Heating 1500 Schools with Edge Data Centers could eliminate approximately 6,255,000 metric tons CO2 over 10 Years**

Source: Energy Star Data Trends, *Energy Use in K-12 Schools*, Jan 2015

Power Capacity	Building Types	Carbon Emission Reduction Estimates	Estimated Heating Cost Savings
500 KW	Small School, Small Office Building, Public Building	200-300 metric tons/year (2500 tons over 10 years)	\$50,000/Year \$1 million+ over 20 Years
1000 KW	Mid-Sized School, Museum, Mid-Sized Office Building, Warehouse	400-600 metric tons/year (5,000 tons over 10 years)	\$100,000/Year \$2 million+ over 20 Years
2000 KW	Large Office Building, Building Complex, Hospital, Industrial Applications	900-1200 metric tons/year (10,000 tons over 10 years)	\$200,000/Year \$4 million+ over 20 Years

Data Center Heat Recovery Possibilities

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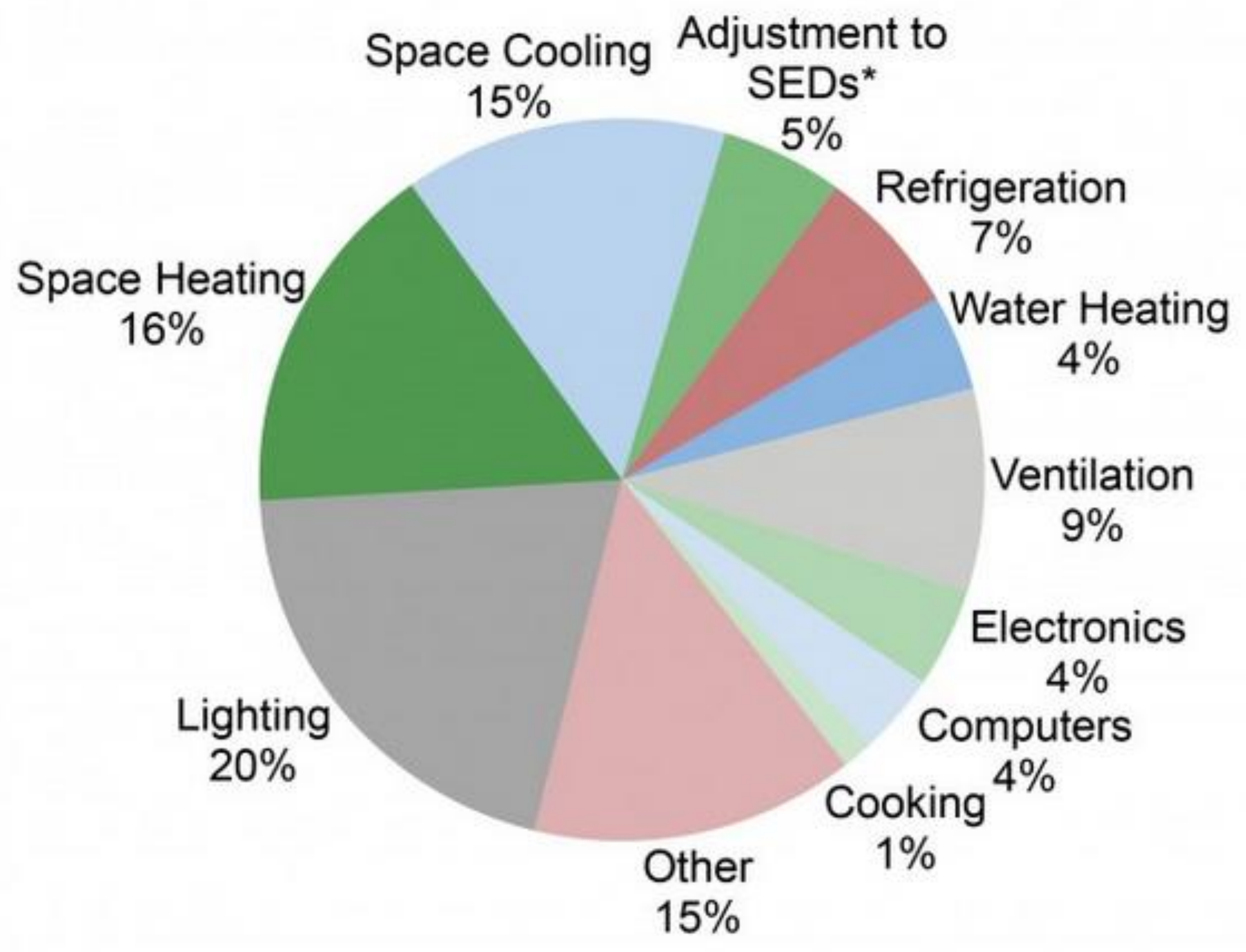
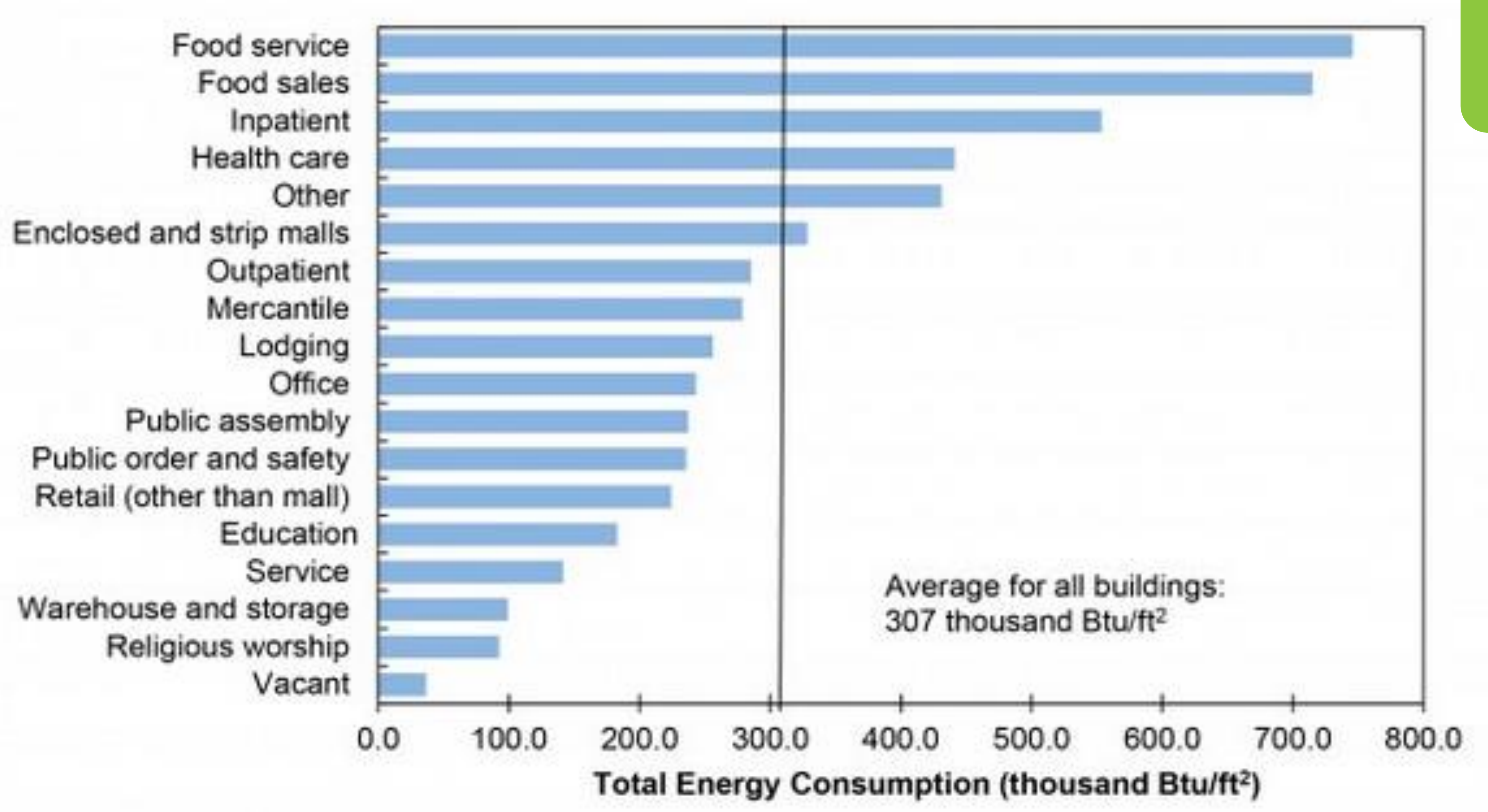
U.S. COMMERCIAL SECTOR PRIMARY ENERGY END USE, 2010[5]



*State Energy Database System (SEDS) is an energy adjustment that EIA uses to relieve discrepancies between data sources. Energy in this case is attributable to the commercial sector, but not to specific end uses.

TOTAL ENERGY CONSUMPTION, U.S. COMMERCIAL BUILDINGS, 2012[11]



Source: University of Michigan Center For Sustainable Systems

Data Center Heat Recovery Win – Win – Win Solutions

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Potential Marketplace Clients

Cloud Providers, Colocation Providers
Schools K-12, Higher Education, Public Buildings, Office Buildings, Apartment Buildings, Industry
Cable/Telecom Providers

Win – Win - Win

Helping Corporate Clients and End Users Achieve Carbon Emissions Reductions
Helping the Environment
Free Heating in Exchange for Free Land/Space Use, No Property Taxes
Shared Generator and Generator Services
Shared IT Services
Potential Dedicated Private Cloud Opportunities, Security Benefits for On-Site Customer Location

Data Center Heat Recovery – Road Map to Success

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Engineering Needs

- Capacity Needs Review
- Ideal Drycooler – 3-way valve – Building Heat Design/Control
- Energy Recovery PUE Calculation and Monitoring
- Rolling Virtual Workload Analysis/AI to Meet Heating Loads
- Redundancy Requirements
- Liquid Cooling for Network and Storage

Site Preferences

- Security Requirements
- Identify Ideal Target Markets
- Engineer Education
- EcoMode Options for 99% UPS efficiency

Service/Maintenance Planning and SLA's

How do I get involved?

If you are interested in participating on a sub-committee to share ideas, information, and practical application for Data Center Heat Recovery Projects

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Email Volunteer Leaders:

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https://www.opencompute.org/projects/data-center-facility

https://ocp-all.groups.io/g/OCP-DCF

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