

# Principles of Hot-Water Cooling

Sommerakademie in Leysin  
AG 2 – Effizientes Rechnen

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# Outline

- ① Introduction
- ② Setup
- ③ Benefits
- ④ Users and experiments
- ⑤ Challenges
- ⑥ Conclusion
- ⑦ References

# Some numbers

Up to 50% of total energy consumption

25,000,000,000 \$ for power and cooling

30 kW of generated heat per rack

100% waste heat

# Water $\gg$ air

- $k_{air} = 0.0262 \frac{W}{m \cdot K}$      $\Leftrightarrow$      $k_{water} \approx 0.65 \frac{W}{m \cdot K}$
- the denser the system is packed, the harder is it to manage the airflow accurately
- water cooling heat sinks allow for even more densely packed systems

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Why is hot water favorable over cold water?

# Cold vs. hot water

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Cold water

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Hot water

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## Cold water

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## Hot water

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The simplest reason is **\$\$\$**  
and -SPOILER- it saves a lot of energy

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# Heat dissipation

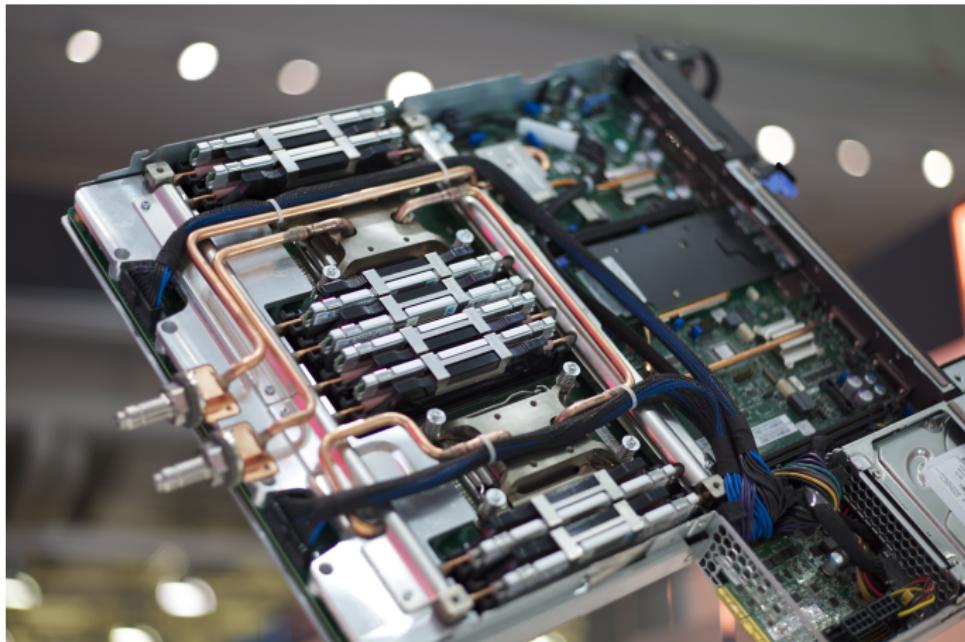


Figure: SuperMUC water heatsinks [3]

# Water circuit

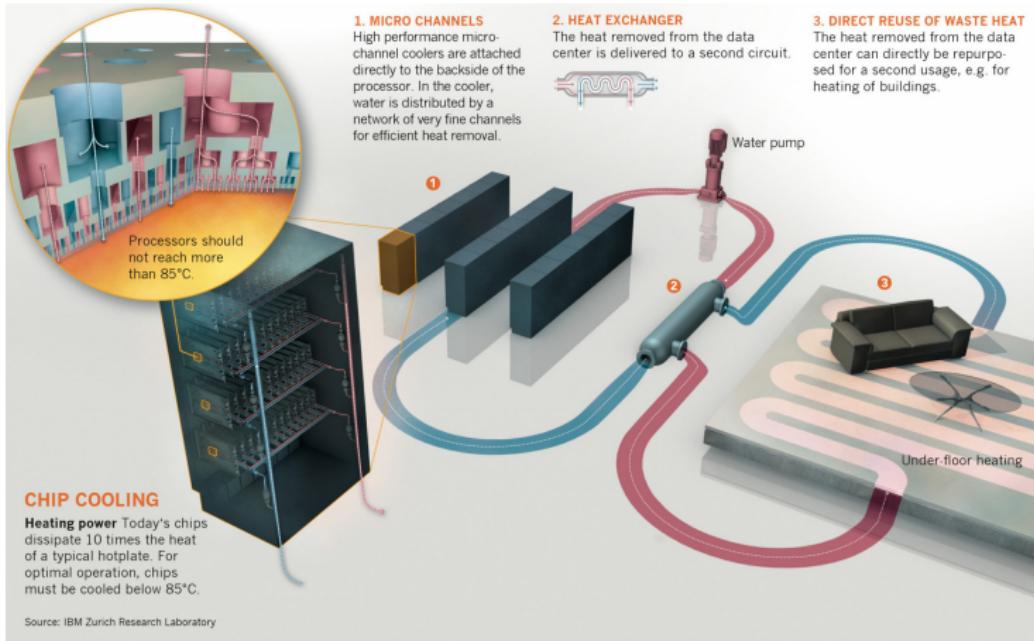


Figure: Water circuit at LRZ [5]

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# Reuse of energy

Different outlet temperatures allow for different utilizations

If  $T_{out}$  is...

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- ... above 45 °C ⇒ heat buildings
- ... above 55 °C ⇒ drive adsorption chillers
- ... even higher ⇒ trigeneration

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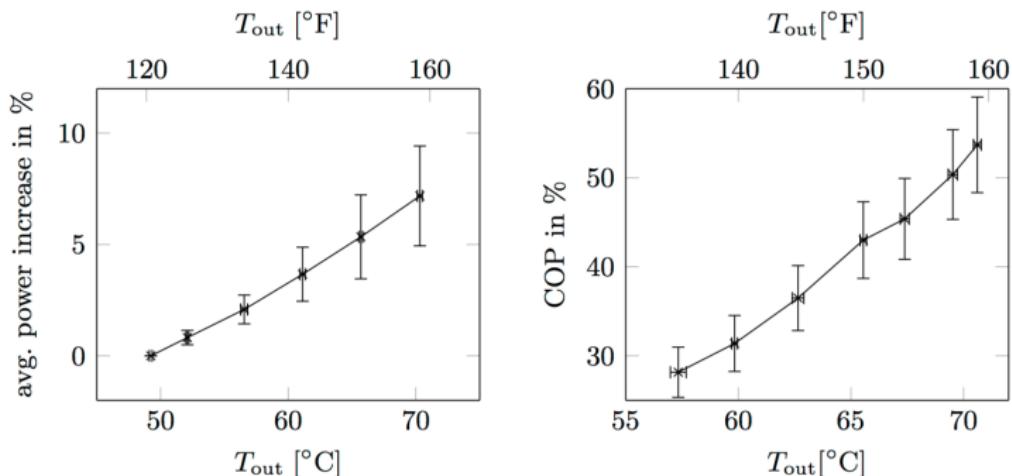
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>>> In general: Higher temperatures are better <<<

# Efficiency improvement



**Figure:** Relative node power increase for 13 nodes with six-core E5645 processors and COP of adsorption chiller [4]

Overall efficiency improvement up to 40 % at SuperMUC

# Carbon footprint



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>> Carbon footprint is improved by up to 85 %

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  - Aquasar cooling system
  - Water temperatures of 60 °C

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# Challenges [4]

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  - loss of heat to the environment
  - decrease of the reusable energy
- Long-term reliability may be harmed
  - water circuit mustn't show any leakage
  - no negative effects at iDataCool after one year of testing

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# Conclusion/Summary

- Hot water cooling makes enormous energy savings through the reuse of waste heat and through free cooling possible
- Due to the complicated installation and maintenance is it currently only used in very few cases and the technology won't be installed in general purpose PCs
- Huge data centers would profit immensely from hot water cooling

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# References I

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