OCP FUTURE TECHNOLOGIES SYMPOSIUM

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Pushing the boundary conditions of data centers facilitates innovative circular economy approaches

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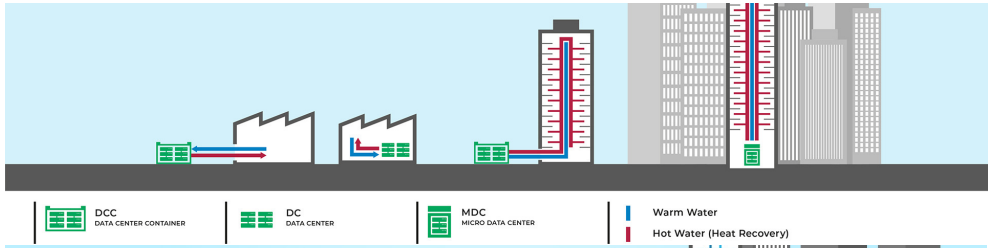
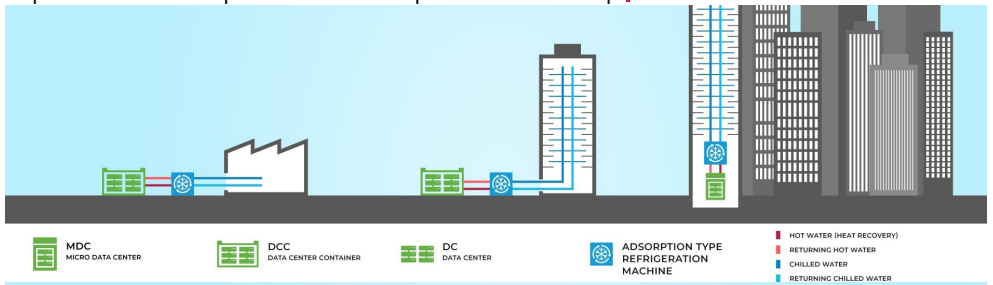
Motivation: Energy to Data, Data to…

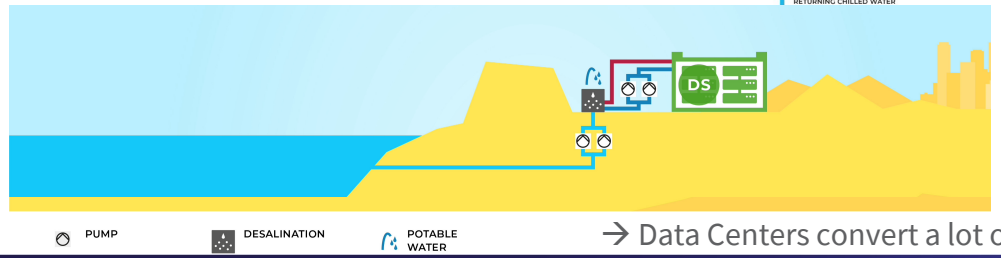
Heat

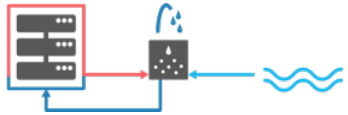


Cooling



Water





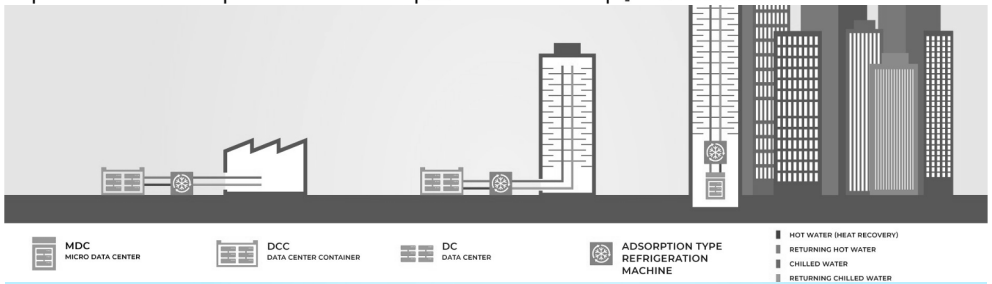
→ Data Centers convert a lot of energy to heat [1-3]

[1] Masanet, E.; Shehabi, A.; Lei, N.; Smith, S. & Koomey, J. Recalibrating global data center energy-use estimates, Science, 2020, vol. 367, pp. 984-986
[2] United Nations Framework Convention on Climate Change (ed.) Adoption of the Paris Agreement, number FCCC/CP/2015/L.9/Rev.1
[3] ASHRAE TC 9.9, Thermal Guidelines for Data Processing Environments, 4th ed., vol 1. Atlanta, GA: ASHRAE, 2015

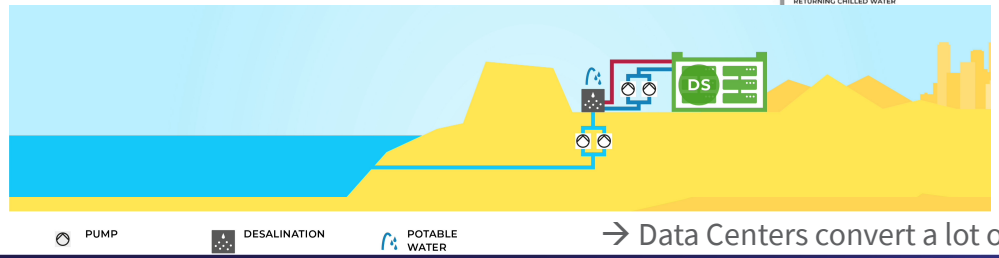
Potential: Energy to Data, Data to Water

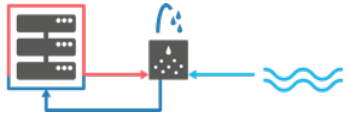
Heat

Cooling



Water





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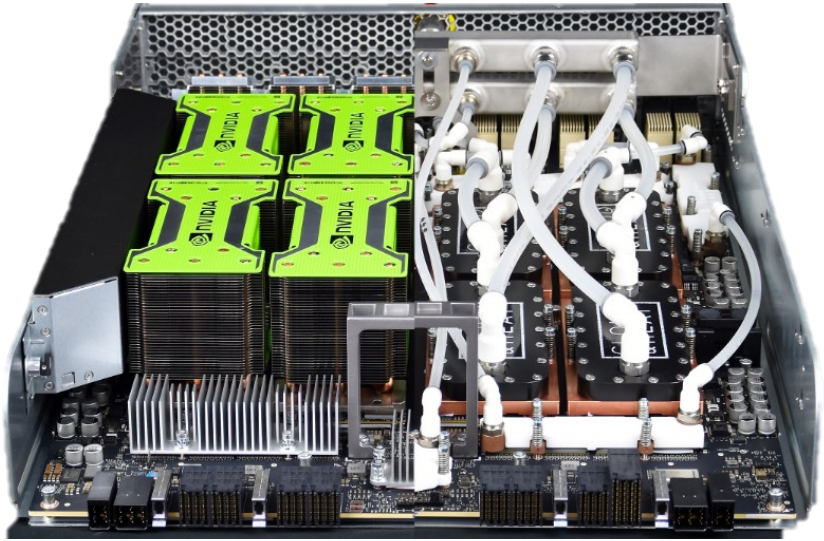
Direct Hot Liquid Cooling (DHLC)

Air-cooled

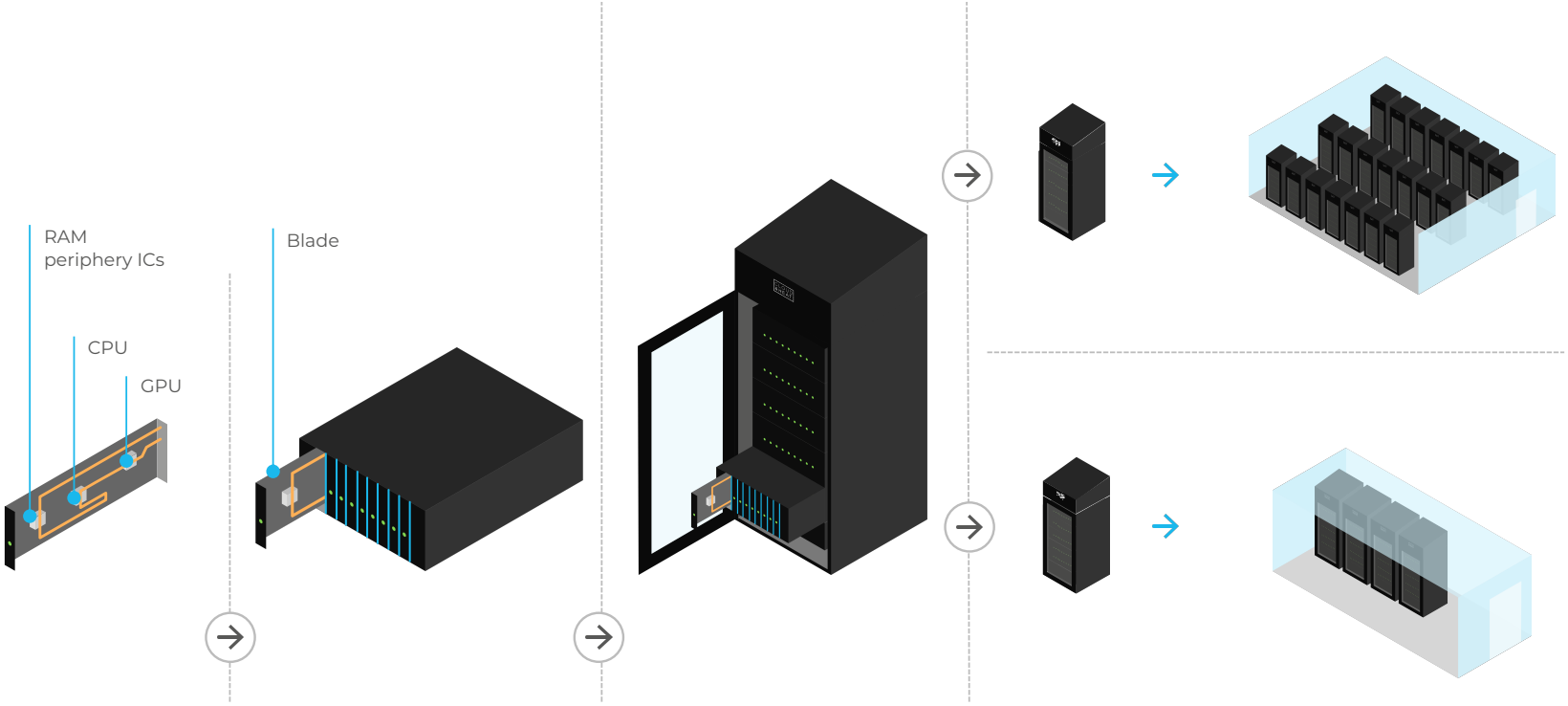


Liquid-cooled

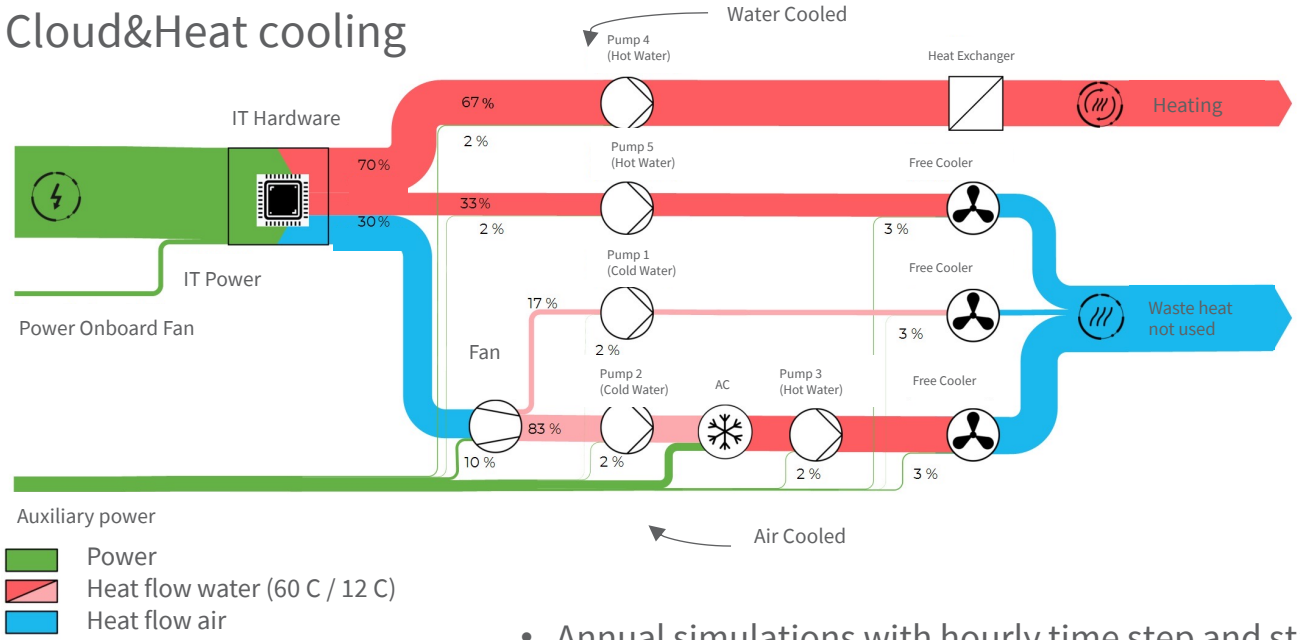
- DHLC captures server waste heat directly in the server [4], [5]
- DHLC with server virtualization and smart load-balancing for circular economy concepts [4], [5]

[4] https://gitlab.com/rak-n-rok/krake, downloaded on 23rd of July 2021
[5] Hantsch, A. Energieeffizienz durch softwaregeführtes Lastmanagement in verteilten Rechenzentren, Bitkom AK Software Engineering und AK

Direct Hot Liquid Cooling (DHLC)



Simulation & Experiments



- Annual simulations with hourly time step and statistically significant experiments [6]

[6] Bronstein, I. N.; Semendjajew, K. A.; Musiol, G. & Mühlig, H. Taschenbuch der Mathematik, Frankfurt: Harri Deutsch, 2001

#1 Result: Strong relation between ERF and heat capture rate for Stockholm (Fig. 1)

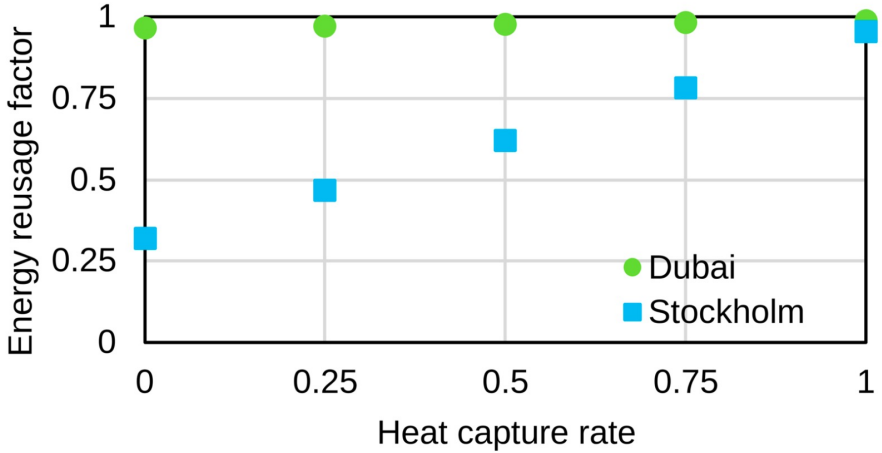


Fig. 1 Energy Reusage Factor depending upon Heat Capture Rate for cold (Stockholm, Sweden) and hot climate (Dubai, United Arab Emirates).

#2 Result: Trend, outlet temperatures between 43 °C and 72 °C (Fig. 2), High degree of dispersion in data in multi-CPU/GPU systems

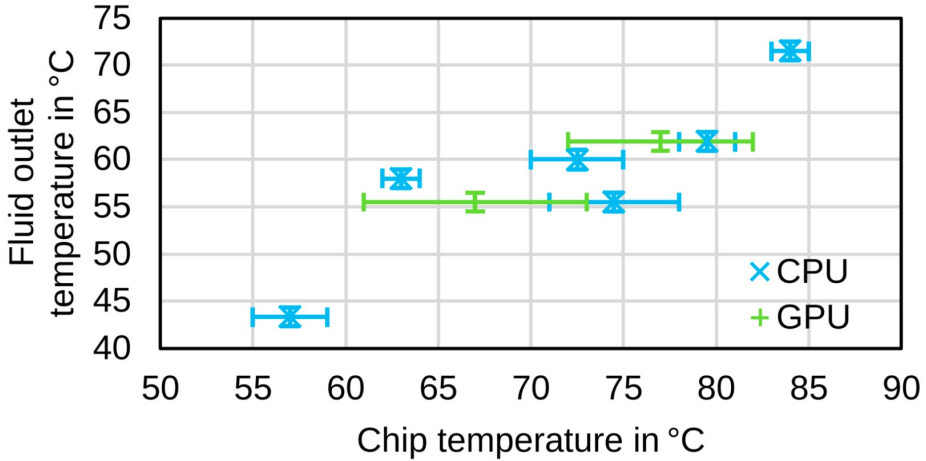


Fig. 2 Coolant outlet temperature depending upon chip temperature for various servers.

#3 Result: High ERF values world-wide for a Cloud&Heat DC (Fig. 3)

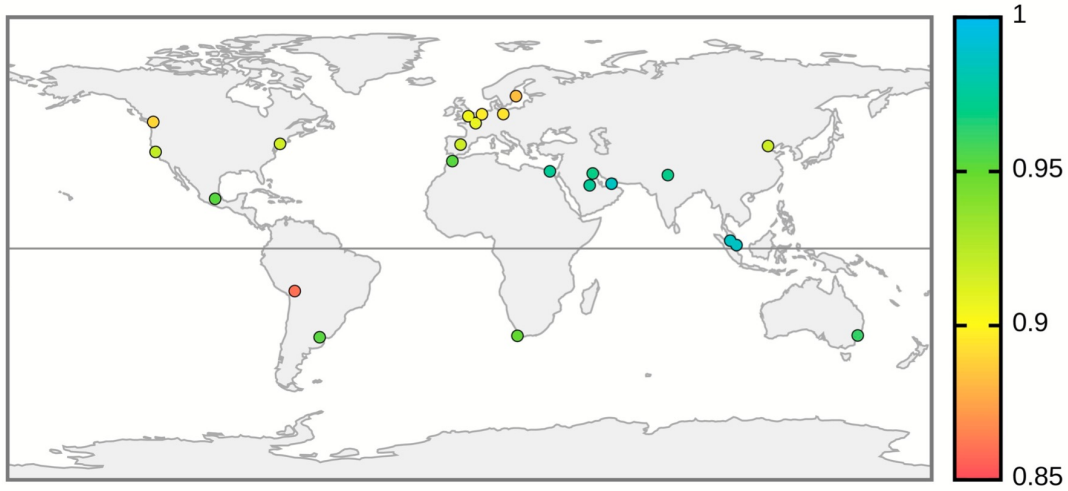
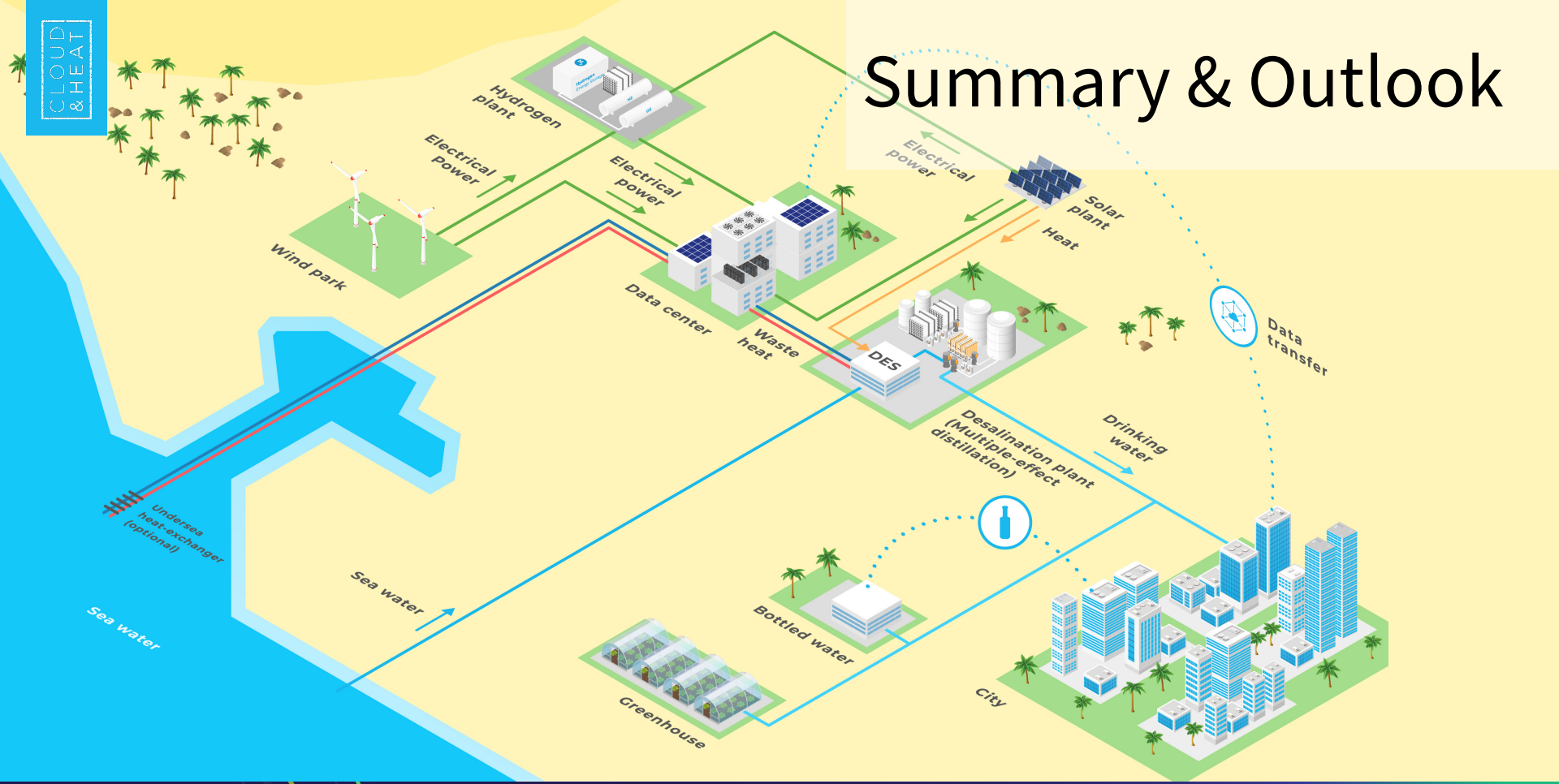


Fig. 3 Energy reuse factor of a Tier III Cloud&Heat DC.

Summary & Outlook



Acknowledgement & References

This work has been supported by the Federal Ministry of Education and Research of the Federal Republic of Germany through the contract 01LY1916C.

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[6] Bronstein, I. N.; Semendjajew, K. A.; Musiol, G. & Mühlig, H. Taschenbuch der Mathematik, Frankfurt: Harri Deutsch, 2001
[7] Dakkak, A. Water Management in UAE, 2020. https://www.ecomena.org/water-management-uae/, downloaded on 23rd of July 2021


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