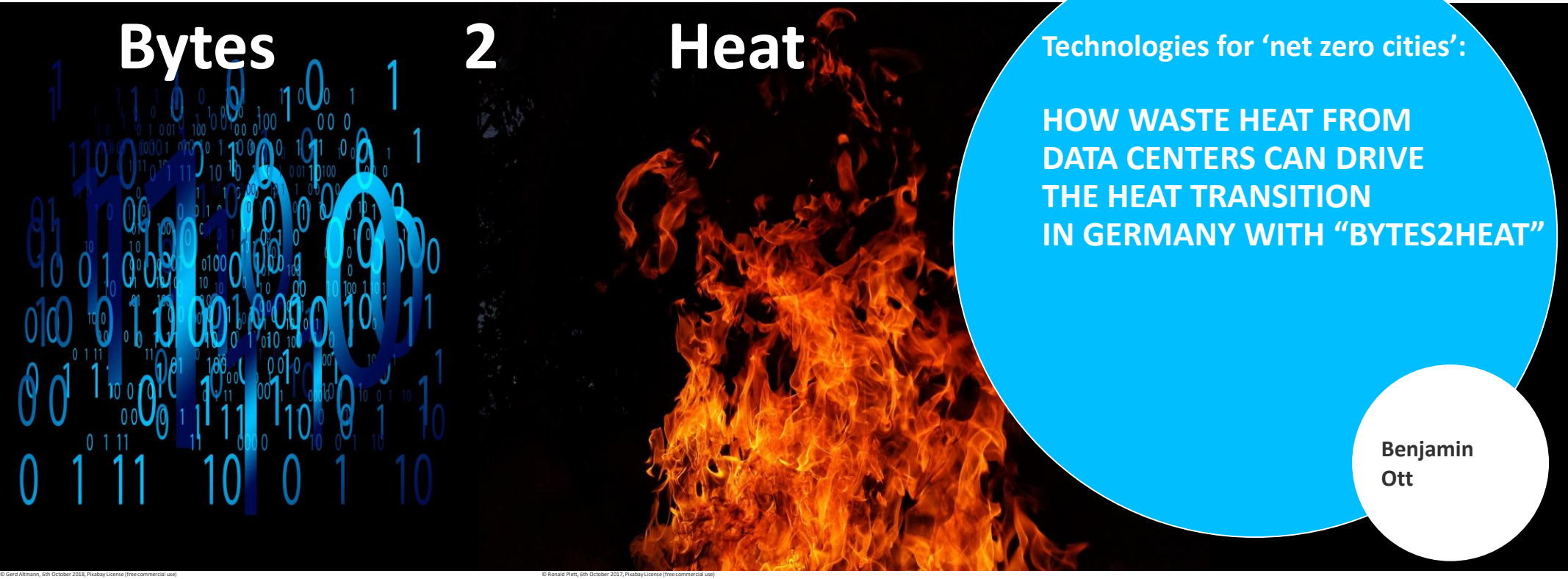
Universität Stuttgart
IER Institut für Energiewirtschaft
und Rationelle Energieanwendung

DENEFF
DEUTSCHE
UNTERNEHMENSINITIATIVE
ENERGIEEFFIZIENZ

IWN
Innovative WärmeNetze GmbH

Bytes 2 Heat



Technologies for ‘net zero cities’:

HOW WASTE HEAT FROM DATA CENTERS CAN DRIVE THE HEAT TRANSITION IN GERMANY WITH “BYTES2HEAT”

Benjamin Ott

How waste heat from data centers can drive the heat transition in Germany.

- **Motivation**
- State of the art
- Approach in the project "EnEff:Wärme: DC-Heat" with "Bytes2Heat”
- Presentation and discussion of results
- Summary and outlook

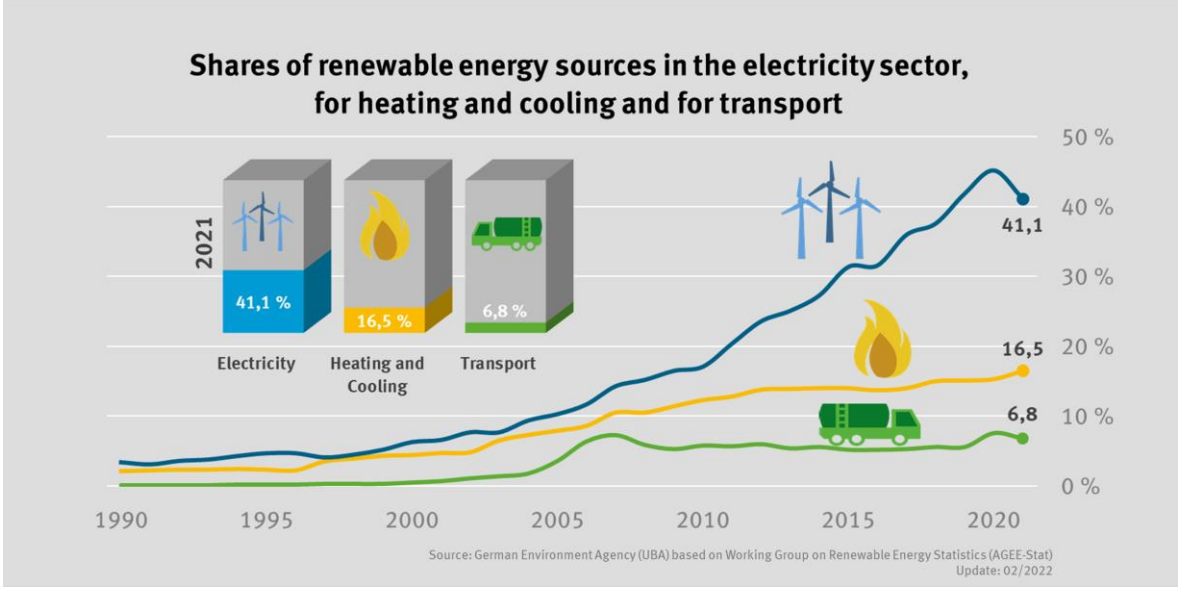
While data centers are of great importance to society, they are extremely power hungry.

- **Data centers** are the **backbone** of **digitalization** and are of great importance to society (**FLAP**)
  - **Electricity consumption** approx. **16 billion kWh** in Germany (2020) [1]
  - **Growth potential** of up to **60 %** by 2025 in Germany [2]
  - Waste heat generated has so far been dissipated unused to the environment → **Could it be put to good use elsewhere? What would be necessary for this?**

The transformation of the power sector is far advanced compared to the heat sector.

In the heating sector, there is an increased need for action on decarbonization.

- German climate protection policy: **Greenhouse gas neutrality** by **2045**
- Large difference between the electricity and heat sectors (**41.1 %** vs. **16.5 %** share of **RE**) [3] → **Could progress in the electricity sector also be used in the heating sector?**



Source: https://www.umweltbundesamt.de/en/topics/climate-energy/renewable-energies/renewable-energies-in-figures (Access: 10.06.2022)

Japan
Electricity: 22,4 % RE (2021)*
Heating: 4,3 % RE (2018)**

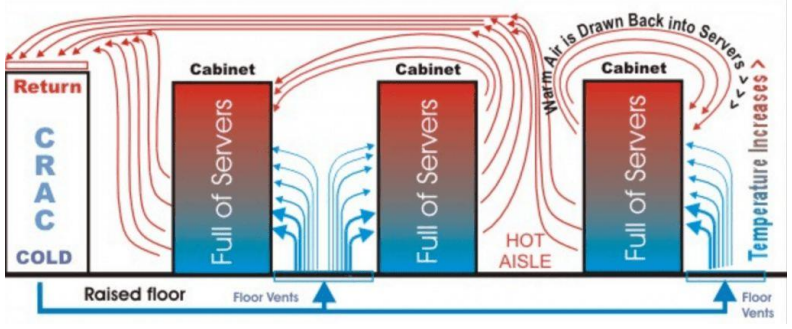
*ISEP: 2021 Share of Electricity from Renewable Energy Sources in Japan (Preliminary), 2022
**IEA: Japan 2021, Energy Policy Review, 2021

How waste heat from data centers can drive the heat transition in Germany.

- Motivation
- **State of the art – Cooling and Heating**
- Approach in the project "EnEff:Wärme: DC-Heat" with "Bytes2Heat”
- Presentation and discussion of results
- Summary and outlook

The type of data center cooling concept has a direct impact on energy efficiency and waste heat recovery potential.

- **Air cooling (Standard method: < 20 kW/Rack)**



Source: https://submer.com/wp-content/uploads/2020/07/data-center-hot-cold-aisle.jpg (Access: 10.06.2022)

- Cold/hot aisle
- CRAC/CRAH
- RDHX

Influence on energy efficiency

- **Waste heat temperature:** up to **35 °C**
- **Percentage** of **electricity consumption** of the **cooling system:** approx. 40 % at PUE* = 1,63

- **Liquid cooling (High Performance Computing: > 20 kW/Rack)**

Source: https://static.lenovo.com/ww/img/dc/neptune/lenovo-data-center-neptune-features-dtn-cooling.jpg (Access: 10.06.2022)

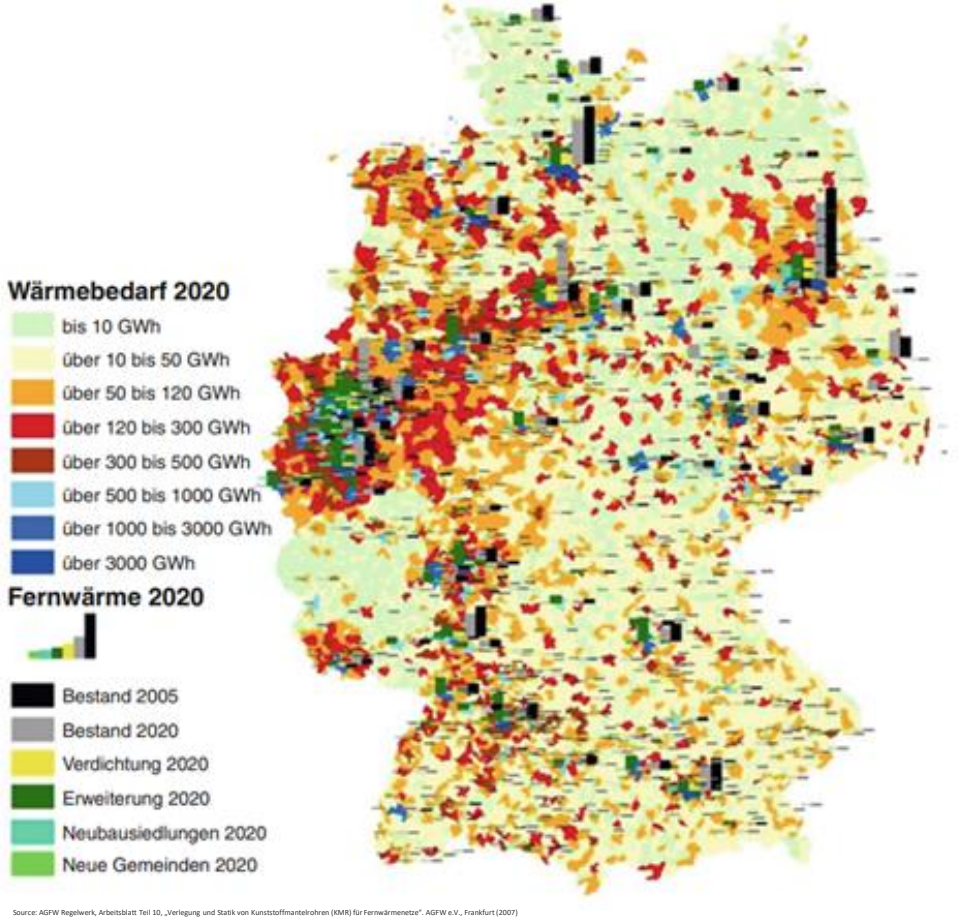
- On Chip Cooling
- Immersion cooling

- **Waste heat temperature :** up to **60 °C**
- **Percentage** of **electricity consumption** of the **cooling system:** approx. 2 % at PUE* = 1,014

$$*Power\ Usage\ Effectiveness = \frac{Total\ Facility\ Energy}{IT\ Equipment\ Energie}$$

One possibility of using waste heat is to feed it into heating networks.
In Germany, however, the district heating network is poorly developed.

- **Heat supply in Germany (2019) [4]**
  - 13.9 % of households heat with district heating
  - 48.2 % of households heat with natural gas
- **Types of heat networks**
  - **District heating:**
    Flow temperature 80 – 130 °C
  - **Low-temperature district heating:**
    Flow temperature 30 – 80 °C
  - **Cold district heating:**
    Flow temperature < 30 °C



Source: AGFW Regelwerk, Arbeitsblatt Teil 10, „Verlegung und Statik von Kunststoffmantelrohren (KMR) für Fernwärmenetze". AGFW e.V., Frankfurt (2007)

Still, there are a few examples in Germany and Japan that use waste heat from data centers. Nevertheless, this does not yet apply to the majority of data centers in Germany.

Waste Heat From Data Center to Heat 1,300 Frankfurt Apartments

Source: https://www.gtai.de/en/invest/industries/energy/waste-heat-from-data-center-to-heat-1-300-frankfurt-apartments-750824 (Access: 27.06.2022)

Cloud&Heat moves into European Central Bank's former data center

Source: https://www.datacenterdynamics.com/en/news/cloudheat-moves-into-european-central-banks-former-data-center/ (Access: 01.09.2022)

See How This Japanese Datacenter is Using Waste Heat to Farm Eels

Source: https://toptechboss.com/see-how-this-japanese-datacenter-is-using-waste-heat-to-farm-eels/ (Access: 01.09.2022)

Why is waste heat from data centers not used on a large scale in Germany?

How waste heat from data centers can drive the heat transition in Germany.

- Motivation
- State of the art
- **Approach in the project "EnEff:Wärme: DC-Heat" with "Bytes2Heat”**
- Presentation and discussion of results
- Summary and outlook

Bytes2Heat aims to promote the use of waste heat from data centers in Germany. To achieve this, the project is tackling a number of issues.

Barriers

Legal barriers

e.g. concern about dependencies and legal and tax disadvantages

Technical barriers

e.g. too low waste heat temperatures as well as the need for 24/365 heat extraction

Operational barriers

e.g. high investment requirements outside the actual core business

Lack of communication

e.g. lack of clarity about possible matches of different stakeholder needs.

Aim

The aim of the project is to make waste heat from data centers economically usable

Who: Data centers, heat consumers and infrastructure providers are brought together
What: Develop innovative solution tools that bring these stakeholders together
How: creative and collaborative co-development process
Why: great potential for CO_2 savings
Result: Data centers can use waste heat economically

How waste heat from data centers can drive the heat transition in Germany.

- Motivation
- State of the art
- Approach in the project "EnEff:Wärme: DC-Heat" with "Bytes2Heat”
- Presentation and discussion of results
- **Summary and outlook**

Summary

- Identification of **technical**, **economic**, **communication** and **legal** **challenges**
- **Development** of a variety of **solution concepts** in **innovation workshops** with all relevant stakeholders

Outlook

- Iterative further development of the prototypes in permanent exchange with the relevant stakeholders
- Initiation of pioneering lighthouse projects and field testing of prototypes

- Publication of the research results and developed tools on the Bytes2Heat platform

We would like to sincerely thank all our supporters!

Project partners

DENEFF
DEUTSCHE UNTERNEHMENSINITIATIVE ENERGIEEFFIZIENZ

IWN
Innovative WärmeNetze GmbH

Universität Stuttgart
Institut für Energiewirtschaft und Rationelle Energieanwendung (IER)
Institut für Volkswirtschaftslehre und Recht (IVR)

Network partners

BFE
Ein Unternehmen der MVV

Danfoss

e·on

DATA CENTER GROUP

ENGIE

Expert network

Stadt Frankfurt am Main

eco
VERBAND DER INTERNETWIRTSCHAFT

VEOLIA

ISS ENERGY SERVICES

Metropolregion Rhein-Neckar

maincubes
SECURE DATACENTERS

Keppel

GASAG
SOLUTION +

GERMAN DATACENTER ASSOCIATION

VATTENFALL

TELEHOUSE

e-shelter

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

Sources

[1] R. Hintemann, „Energiebedarf der Rechenzentren steigt trotz Corona weiter an“. Cloud Computing profitiert von der Krise, https://www.borderstep.de/wp-content/uploads/2021/03/Borderstep_Rechenzentren2020_20210301_final.pdf (Access: 16. January 2022), 2021

[2] Wissenschaftlicher Dienst des Deutschen Bundestages, „Energieverbrauch von Rechenzentren“. Sachstand, Berlin WD 8 - 3000 - 070/21, https://www.bundestag.de/resource/blob/863850/423c11968fcb5c9995e9ef9090edf9e6/WD-8-070-21-pdf-data.pdf (Access: 13. February 2022), 2021.

[3] Arbeitsgruppe Erneuerbare Energien-Statistik, „Erneuerbare Energien in Zahlen“, Dessau-Roßlau, https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen#uberblick (Access: 10. June 2022), 2022.

[4] BDEW Bundesverband der Energie- und Wasserwirtschaft e.V., „Wie heizt Deutschland 2019?: BDEW-Studie zum Heizungsmarkt“, Berlin, https://www.bdew.de/media/documents/Pub_20191031_Wie-heizt-Deutschland-2019.pdf (Access: 10. February 2022), 2019.

Universität Stuttgart
IER Institut für Energiewirtschaft
und Rationelle Energieanwendung

Thank you very much!

Benjamin Ott

Mail benjamin.ott@ier.uni-stuttgart.de
Phone +49 (0) 711 685- 87826
Fax +49 (0) 711 685- 87873

University of Stuttgart
Effiziente Energienutzung (IER)
Heßbrühlstr. 49a, 70565 Stuttgart, Deutschland