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Renewable Energy from Waste Water- High potencial for the heating and cooling revolution

DecarbCities Vienna 2020
Dr. Rainer Wiedemann
Rabmer Greentech GmbH

Rabmer Group –
Innovation based on tradition

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- International business group with the headquarter in Altenberg near Linz, Austria
- A family owned company in 2nd generation, founded in 1963 by Josef und Maria Rabmer
- Sole shareholder: Mag. Ulrike Rabmer-Koller
- Enterprises: Construction and Real Estate, Municipal Services, Environmental Technologies (GreenTech), Management and Consulting
- Further information: www.rabmer.at




Energy from wastewater - WHY?

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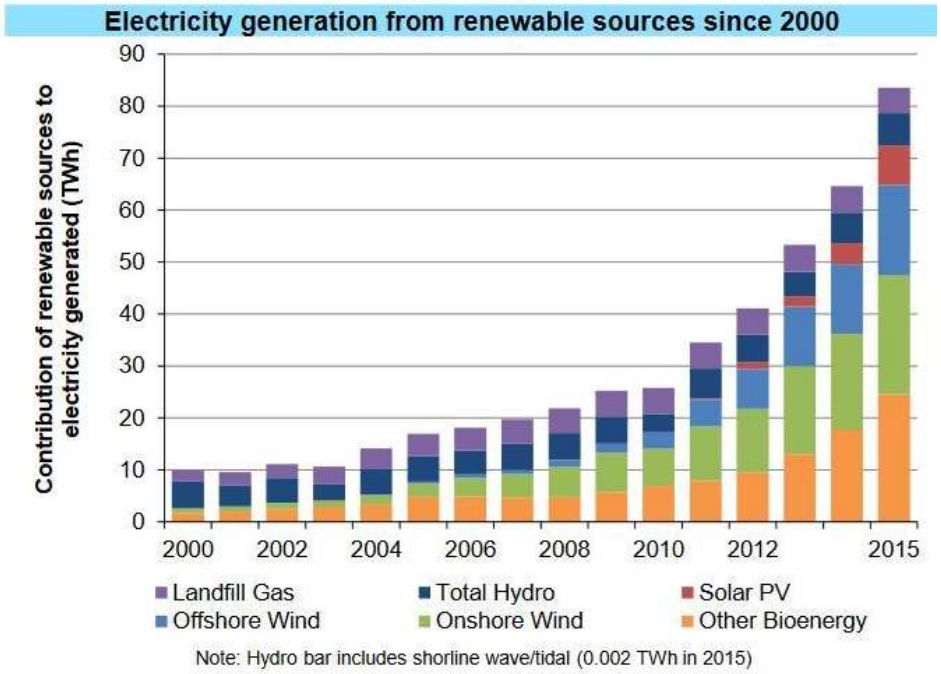
- Heating and cooling account for 46% of finally energy consumption worldwide
- Renewable energy becomes more and more important
- BUT
  - Mainly as electricity
  - Not for cooling and heating
  - Focus on solar and wind – solutions with limitations in
    - availability
    - storage
    - disposal of batteries, etc.



Energy from wastewater - WHY?

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- **AVAILABILTY - 24 HOURS - 365 DAYS**
- **USE IN URBAN AND INDUSTRIAL AREAS** -> where energy is needed for cooling and heating
- **HIGH OUTLET TEMPERATURES**
  - **12°C – 18° - 20°C in sewers**
  - **30°C and more in industry**
- **CITY CENTER INSTALLATION – substancial contribution to climate protection**
- **ENERGY FROM WASTEWATER = *Renewable Energy since Dezember 2018 – EU-wide***

From intelligent housing technologies, heating/cooling to district heating !!!

Areas of applications

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- **Showers – ZYPHO®**
- **Housing Technology**
  (municipal, commercial, hospital, hotels, etc.)
- **Sewage System – Gravity Pipeline**
  (heating and cooling with heat exchanger in the „Energy distribution channel“)
- **SEWAGE System – External heat exchanger**
- **Sewage System – Pressure Pipeline**
- **Wastewater Treatment Plant**
  („prior“ and „subsequent“)
- **Thermal Water**

Housing Technology – Requirements

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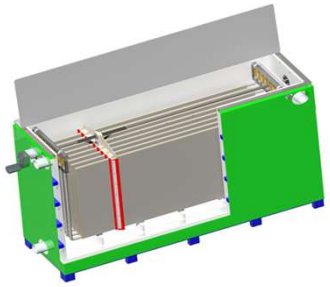
- General requirements
  - **Continuous available quantities of waste water required**
  - **Flow rate: > 2 -20 m³ per day**
  - **Residential buildings: grey water and sewage water pipes separated**
  - **Central water heating**

- Depending on
  - **Temperature**
  - **Proximity to the consumer**
  - **Heat exchanger design**
  - **Operating hours**
  - **Cleaning requirements**
  - **Engaged technology**
  - **Permits, etc.**



Housing Technology

- Use of innovative heat exchangers with or without heating pumps
- Daily self-purification
- Connection to the energy system according costumer-specific configuration
- High performance with low space requirements (30 - 40 - 100 kW)
- Payback time: 4 to 5 years

Housing Technology – areas of applications

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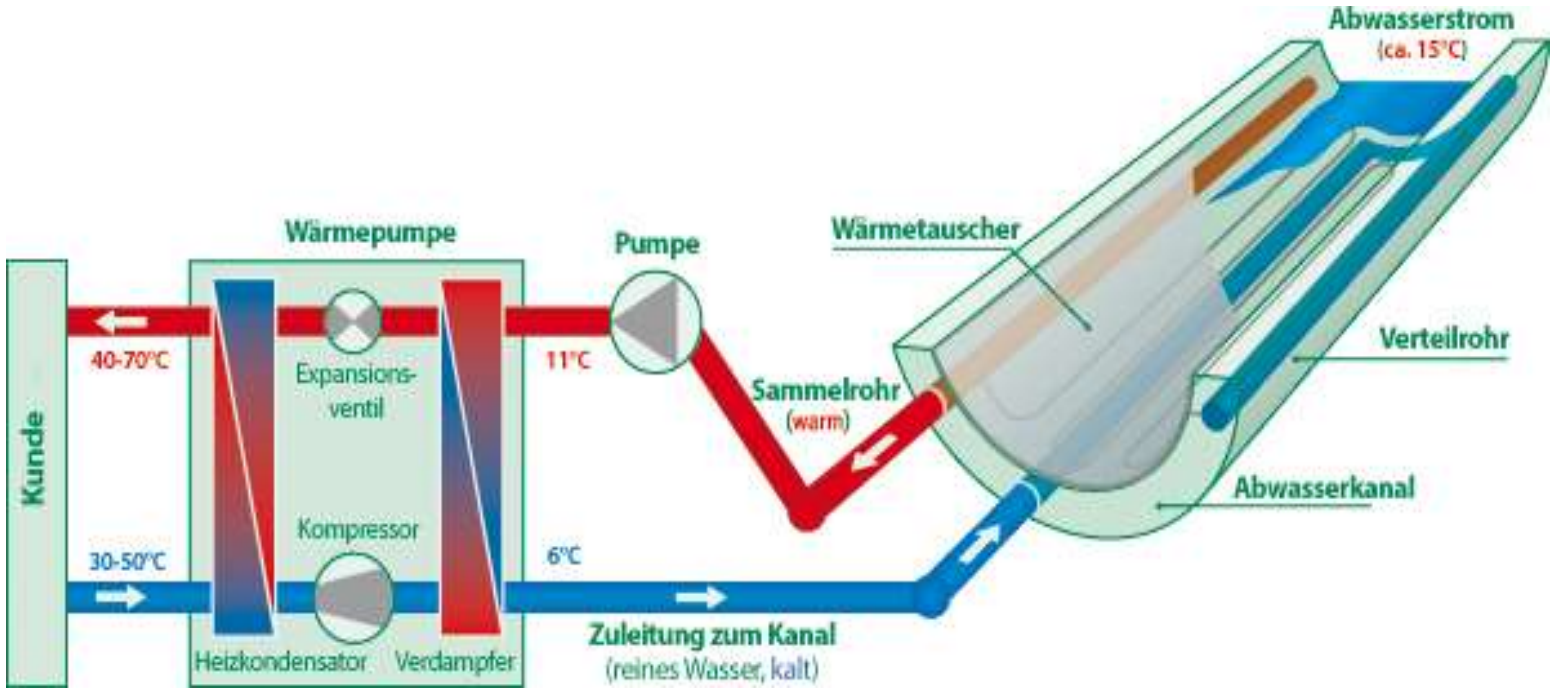
- **Potential applications for heating, cooling, water pre-heating, etc.**
  - hospitals
  - thermal pools, recreational areas
  - nursing homes, convalescent homes, etc.
  - commercial kitchens/canteens
  - laundry facilities
  - food processing industry
  - slaughterhouses
  - bottling plants
  - paper mills
  - textile and leather industry
  - etc.

Sewage System



Scheme „Use in the sewage system“

Sewage System - Requirements

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- **Flow rate**
  - at least 10 l/s (daily mean during dry weather)
- **Temperature:** min. 10-15° C
- **Min. required duct diameter**
  - 400 mm for prefabricated elements
  - 800 mm for subsequent installations
- **Cooling of wastewater in the channel**
  - after use only in exceptional cases > 0.5°C
- **Distance channel to the consumer:** max. 300 m (> 2 MW 1000 m)
- **Connected consumer:** min. 50-80 kW
- **Wastewater heat utilization in the channel**
  - about 2.5 kW/m² of heat exchanger surface can be achieved

Standard values – depending on design, permissions, authorization by operator, operation hours, cleaning requirements, technology,…

Commercial housing - waste water as excellent source of energy

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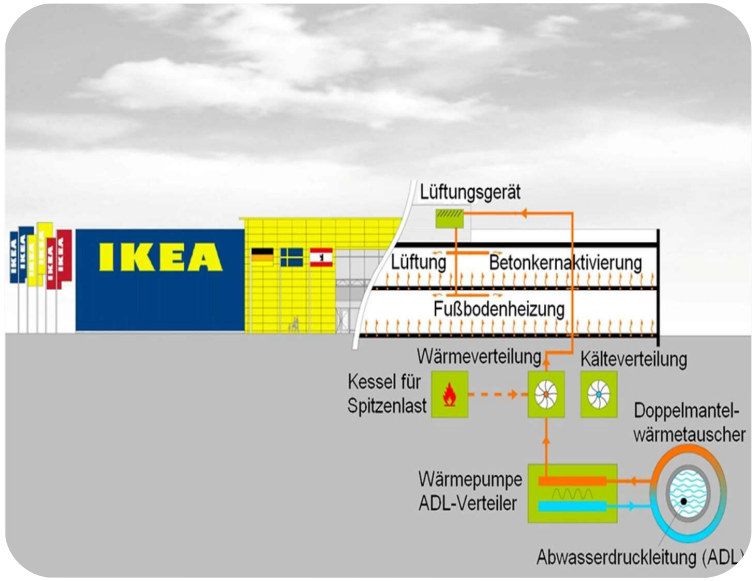
- **Examples of realised projects (> 80) commercial housing – *Uhrig company / Rabmer***
  - Rheine 2019, 105 kW extraction rate heating, 113 kW cooling
  - Frankfurt Europaviertel 2014 , 300 kW e.r. heating, 535 kW cooling
  - Wangen im Allgäu, 2019, 400 kW e.r. heating
  - Stuttgart Katharinenhospital 2019, 300 kW e.r. heating, 484 kW cooling
  - Innsbruck IKB 2018, 150 kW e.r. heating
  - Vienna Wienkanal 360 kW e.r. heating 750 kW cooling
  - Planning retirement home Arnsberg 2018, 200 kW extraction rate (Rabmer-Uhrig)

IKEA Berlin

- wastewater pressure pipeline
- diameter: DN 1000 mm
- length of heat exchanger: 204 m
- wastewater quantity: 500-1,300 m³/h (annual average)
- 3 heat pumps
  - about 1,500 kW heating capacity and
  - 1,200 kW cooling capacity
- max. cooling of wastewater: 1.6 K



Sewage system – gravity pipelines technology overview

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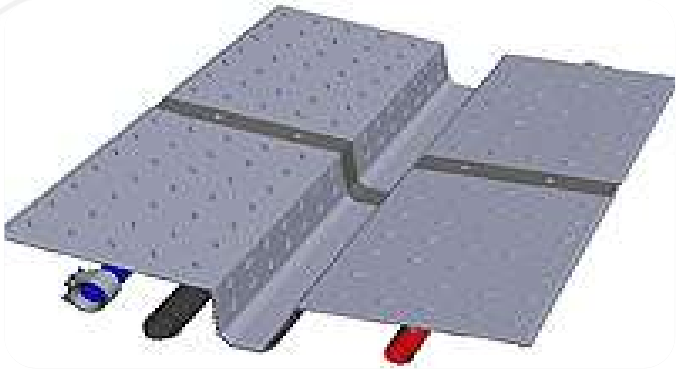
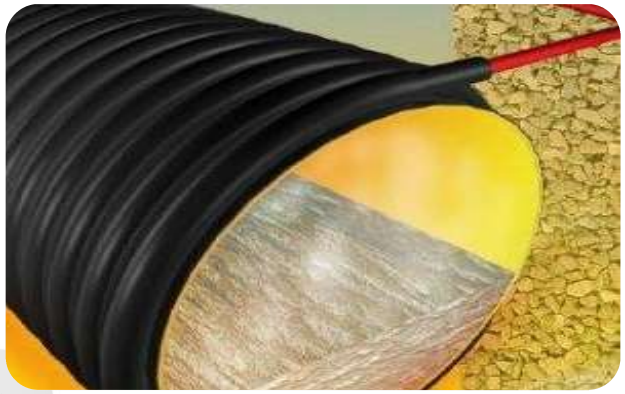


”walk-in channel“ heat exchanger

integrated in the concrete pipe



sewer pipe - outside

external heat exchanger

Heating and cooling of buildings/industry

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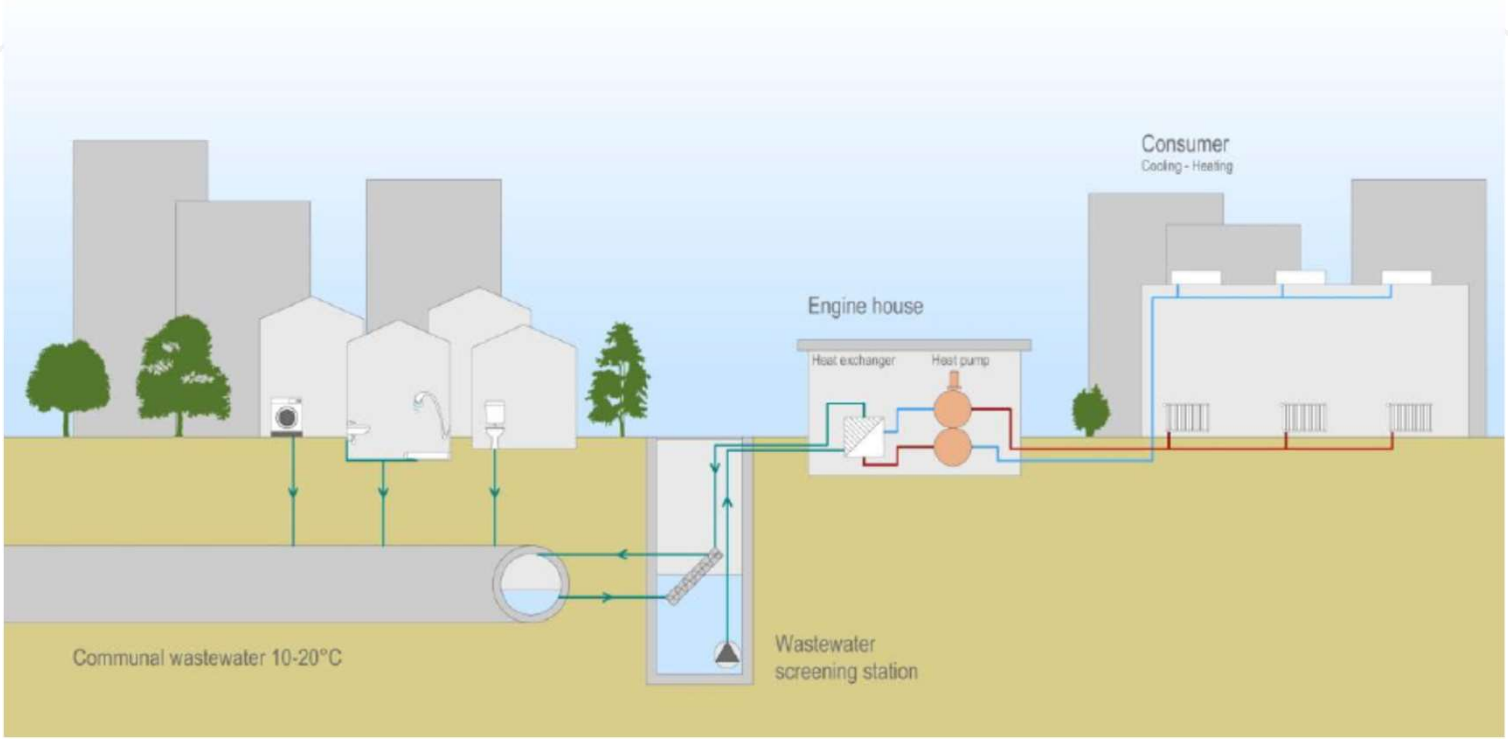

Scheme external use of energy from wastewater from sewer with external heat exchangers for applications > 500 kW power

Innovative large-scale plants
External heat exchanger

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Heating/Cooling of buildings with demands > 500 kW **Thermowatt - technology**

- self-purifying tube bundle heat exchanger in combination with heat pump for heat recovery installed outside the duct
- use of wastewater from respective main collector
- removal of 2,000 to 10,000 m³ per day
- water lifting via bypass procedure, separated manhole
- self-developed lifting and screening technology
- heat loss through external tube bundle heat exchanger

Figure: Heat exchanger with high self-purifying effect controlled via screening technology and speed of wastewater

Innovative large-scale plants
partnership for implementation, operation

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- high performance heat pumps up to 4 MW
- complete heating and cooling of buildings
- design, construction, operation, maintenance/repair
- international planning and operating team
- project and operating experience for more than 5 years
- heating and cooling services are interchangeable
- payback time: 5 to 7 years

Figure: high performance heat pumps with high performance coefficient (COP) precise adjustment on heat demands (inverter technology)

THERMOWATT- Reference
„Military-NATO-hospital Budapest“

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- Military hospital Budapest
  - www.honvedkorhaz.hu/
- installation EfW plant in 2014 /Thermowatt Kft.
- heating and cooling of the hospital from waste water
  - up to 3.8 MW heating
  - up to 3.2 MW cooling
- Utilizing sewage outside the sewer
- project implementation: Thermowatt Kft. –

as exclusiv technology partner of Rabmer

Thermowatt- Reference
„Military-NATO-hospital“ Budapest

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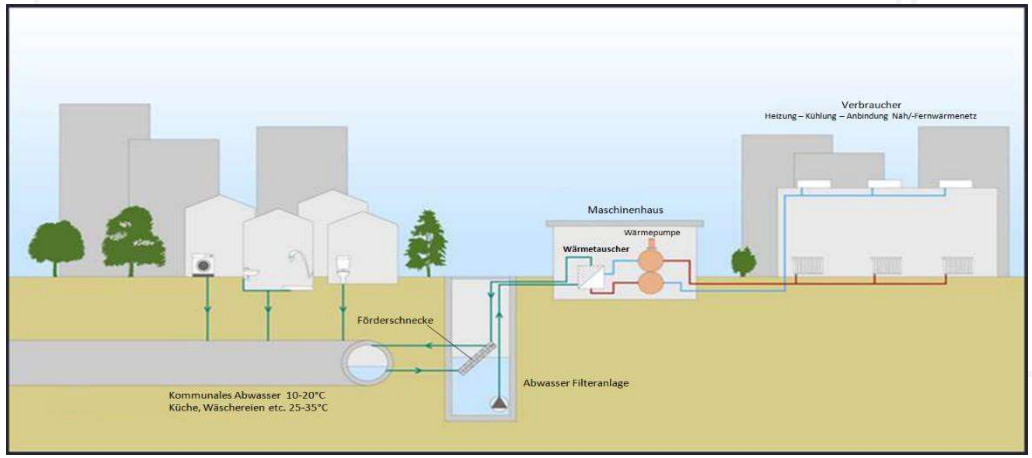
Initial situation

- main sewer in Budapest with 2.6m diameter close to the hospital
- used waste water volume: 500 m3/h
- available temperature: 15 – 17°C

Solution approach

- waste water flows via a bypass and shaft
- Flows through 18 innovative heat exchangers outside of the sewer
- use of two high power heat pumps with special configurations
- use for heating- and cooling system



THERMOWATT- Reference „Military-NATO-hospital Budapest“

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- High - performance heat exchangers / Thermowatt Kft.
  - 18 heat exchangers with 200 kW power per unit (L 3m, 0.6m)
  - 12 in operation – 6 stand by, maintenance possible without operational downtimes
  - high self-cleaning effect , controlled by screening technology and waste water speed

THERMOWATT- Reference „Military-NATO-hospital Budapest“

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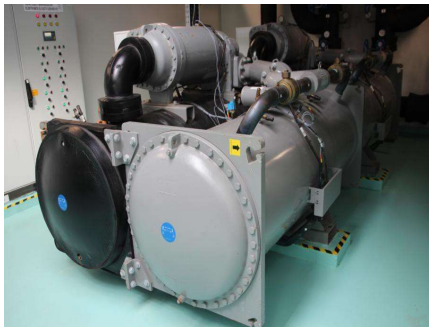

- Use of high power heat pumps – Carrier company
  - 2 heatpumps each with 1.9 MW heating- and 1.5 MW cooling power
  - first pump for base load, second pump for variable demand
  - COP – value partially higher than 7.5 !!!

Energy from Wastewater
Trends/Perspectives

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- **can play an important role in the decarbonization of cities!**
- **between 10-15% of the heating needs in Europe can be covered by Energy from Wastewater!**
- **optimization** and further development of existing products
- improved energy output
- **increasing lifetime** of heat exchanger (50 a), high-efficient „wastewater“-heat pumps etc.
- new manufacturers, products, patents, -
  growing technology ranges
- **anti-fouling-systems** – increased heat exchanger performance
- **high degree of prefabrication** reduces installation costs
- shorter **payback periods** (from > 20 to 3-6 a)

Energy from wastewater - we check for you the potential!

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- **we check the potential in advance:**
- **checklists for example with**
  - need for heating/cooling
  - planned operating hours
  - new building/refurbishment
  - data about waste water like
    - Dry water drain (from 10 l/sec)
    - temperature (winter/summer, minimum 8-10°C)
  - dimension and slope of sewer (from DN 400)
  - available sewer length or external heat exchanger position
  - distance sewer- external heat exchanger - energy center
  - etc.
- **Initial assessment, as required rough calculation , funding instruments!**

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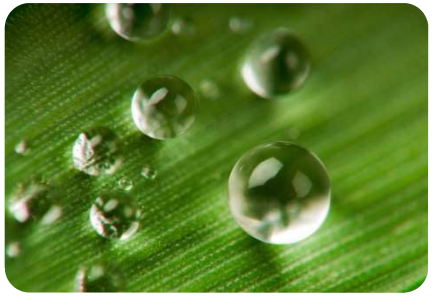

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Reservefolien

Reference
AKH Linz

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Problem

- 10 m³ kitchen wastewater, 25-40 °C, direct discharge into the sewer system
- no space for the heat exchanger in the kitchen

Project aim

- energy savings through pre-heating the fresh water with energy from wastewater

Realization

- application of self-purifying counter-flow – plate heat exchanger without a heat pump
- continuous flow system, 2 m² space requirements

Result

- pre-heating of the fresh water from 10 °C to 24 °C with the heat exchanger
- payback time: about 5 years

Reference
Hummelhofbad Linz

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Problem

- hot wastewater stays for 1 day in a settling tank for chlorine and is then discharged unused into the sewer system

Project aim

- energy savings through pre-heating the fresh water with energy from wastewater

Realization

- usage of a static system with a 24 h retention period
- installation of an integrated smooth pipe heat exchanger in the retention basin

Result

- pre-heating of the fresh water from 10 °C to 24 °C with the heat exchanger
- savings: ca. 250,000 kWh/year

Thermal Water technology overview

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- **use of heat exchangers and heat pump**
- **commonly use of thermal water overflow, more than 30 °C**

- **reference Leukerbad/Switzerland**
  - use of 8-9 l/s wastewater stream
  - withdrawal of 450 kW
  - special connected, external heat exchanger + heat pump
  - self-purifying system

Sewage System – Gravity Pipelines Technology

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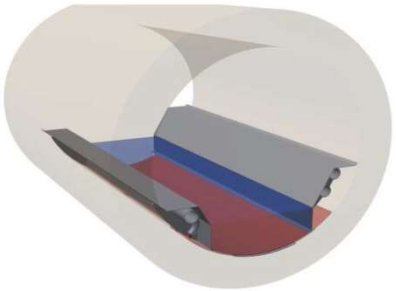
- **Channel heat exchanger (CHE) in general**
  - Suited for all channel types
  - Industrially manufactured plate heat exchanger made of stainless steel
  - Installation in existing and new built channels possible
- **CHE for dry weather**
  - Distribution lines below side plates
  - complete overflow during periods of dry weather
  - Advantages: quick installation, no visible pipes
  - Disadvantages: more difficult access for inspections, and so on.
- **CHE in shell shape**
  - Distribution lines above/below shells
  - Advantages: quick installation, access for inspections, low cross-section loss in the channel
  - Disadvantages: higher investment costs



Sewage System – Gravity Pipelines Technology

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- **In concrete pipe integrated heat exchanger**
  - Advantages
    - Fast installation
    - Standard product
      „Tailored solutions“
  - Disadvantages
    - No access for inspections, audits
    - Only suitable for new channels
    - Vulnerability to cuts, uplift, and so on.

Sewage System – Pressure Pipelines Technology1)

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double jacket - external

with distribution lines

as insertion

double jacket in the channel

[1] installed in combination with wastewater heat pumps

Reference SPAR Salzburg – Cooling System

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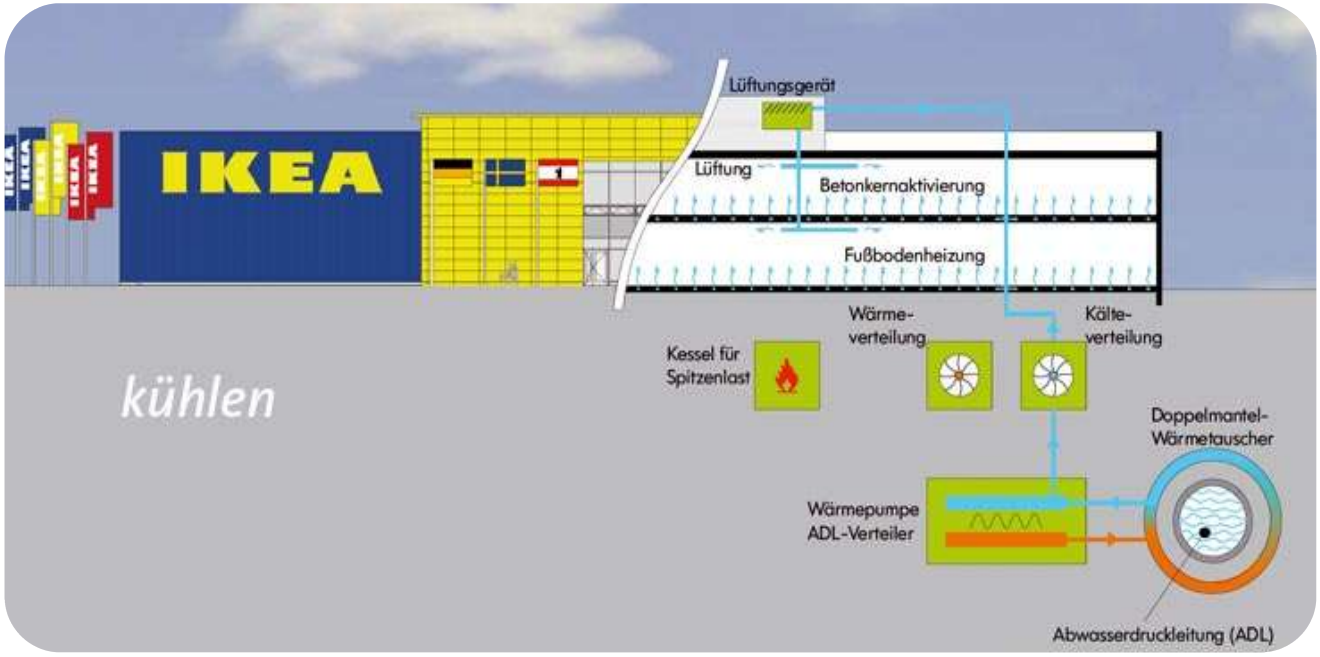
- **use of wastewater energy from „Almkanal“ in Salzburg**
  (protected monument – 12th cent.)

- **cooling (111 kW) 2 SPAR-markets Getreidegasse Salzburg**

- *for details see report „Almkanal Salzburg – SPAR Markt“ Ing. Andreas Wachter, Moser&Partner*

IKEA Berlin – Cooling System

- payback time overall system: 6 years
- CO_2 savings: 532 t/a



Sewage System – Pressure Pipelines Technology

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Double jacket tube – heat exchanger

- installation in existing pressure pipelines or in new constructions
- replacement of existing pressure pipelines
- bypass – Solution for pressurized pipes

Advantages

- High amounts of wastewater
- Minimal pressure loss through heat exchanger
- Heat extraction from the entire pipe circumference

Disadvantage

- No access for inspections

Energy from Wastewater
„Not an invention of the present“

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- **Germany**
  - First patents in 1970
  - First projects in 1982
  - Esslingen, Wiesbaden, Berlin
- **Switzerland**
  - First technologies and references 40 years ago
  - First plants in channels in 1982, the first patents in 1996
- **Austria**
  - References in residential buildings, channels and industrial application

Sewage System – Gravity Pipelines Technology

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External heat exchanger

- self-purifying tube bundle heat exchanger in combination with
- heat pump for heat recovery installed outside the duct

Advantages

- resistant heat exchanger
- especially designed for wastewater and sludge
- self-purifying

Disadvantages

- wastewater abstraction and external pumping station required
- higher investment costs
- additional space and energy requirements
- recirculation of screenings into the channel

Energy from Wastewater potential for the future

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It‘s already possible to find individual, optimal solutions for specific requirements within a wide range of technology in the field of „Energy from wastewater“

- based on practical feasibility studies,
- on project planning/technology selection, construction/installation and comissioning
- resulting in a smooth and economic operation!

THERMOWATT- Reference „Military-NATO-hospital Budapest

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Sewage shaft to lift waste water

- own development of transport-, screening and filtering technology by Thermowatt Kft.
- backwash treatment for solid particles to the sewage network /shaft

Energy from Wastewater
Trends/Perspectives

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- **reduction of prejudices on**
  - Treatment plant,
  - Channel operator,..

  ➡ no disadvantages on the treatment plant
- **energy generation in the treatment plant or in the water run-off is increasing**
- **sectors “housing technology“ and “industrial applications” are growing rapidly**
- **public heating !**
- **contracting models for 15-30 years possible**

Energy from wastewater - WHY?

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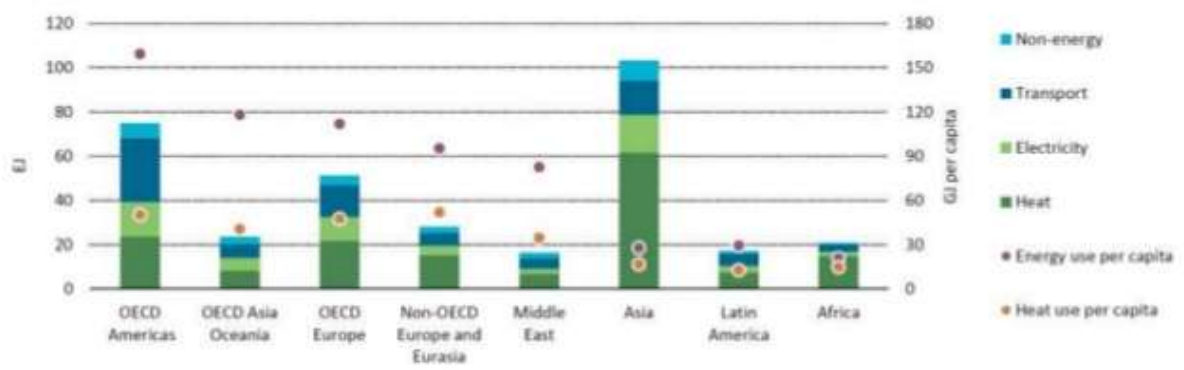
Decarbonising heating and cooling: neglected but necessary

ETP 2012

Total final energy consumption by region as electricity, heat, transport and non-energy uses, 2009



Heating and cooling account for 46% of final energy consumption worldwide.

iea International Energy Agency