WASTEWATER-HEAT RECOVERY IN PRACTICE

DECARBONISED HEATING AND COOLING OF LARGE BUILDINGS

Pál KISS
managing director

THERMOWATT Ltd.
Established in 2007, in Budapest (Hungary) specifically for energy utilization of waste-heat.

Activities:
- Utilization of communal wastewater and thermal water for heating and cooling
- Energy consultation
- Installation of gas engines (preferably biogas engines)

Co-operating partners:
DIRECTIONS TO GROW

PRESENT:
- Running systems and 24/7 operation → more than 6 years experience in operation and installation
- Continuous research, adjustments and fine tuning to improve the system
- Preliminary studies, several project-preparations
- Presence on international markets: project company in the UK; agents (France, Benelux, Austria; Kuwait, Egypt: contracting in process), close cooperation (Canada, Vietnam, Malaysia, Thailand, Bulgaria, Romania, Czech Republic, Germany, Singapore)

FUTURE PROSPECTS:
- Close cooperation under negotiation: UAE, Spain, India, Mexico, China, Brasil
- ISLE Utilities (technology transfer to waterworks) – US, UK, EU, Australia
- Remote supervision, technical assistance for operation of systems implemented abroad
INVENTION OF THE TECHNOLOGY

- Developed a technological solution to harness and utilize energy resided in wastewater to cool and/or heat buildings in a modern, environment-friendly and economical fashion.

- “Method and Circuit Arrangement for Recovering Heat from Wastewaters”
  - Hungarian Patent – granted, protection since 2010
  - International Patent (PCT) – applied for in 2011
  - Russian, Ukrainian Patent - granted

- International Innovation Award winner technology:
  - *Aqualia Award for Innovation 2013* and
  - *First Place Innovator in the Water for Real Estate Sector* at the Innovate@IWS 2015 in Abu Dhabi
THE THERMOWATT TECHNOLOGY
The THERMOWATT Technology – Features of a Heat Pump System

- Suitable for water heating systems up to 63 °C and for practically any cooling system
- Air-air, air-water heat pumps are less efficient
- Uses electricity
- Continual efficiency growth of the equipment
- The efficiency of systems can be improved by adjusting them to the given location (thermal water, pool, waste heat, etc.)
The efficiency (COP) is directly proportional to the temperature difference between the heat source and the destination.

Given its constant favourable temperature the optimal heat source is the wastewater.
THE THERMOWATT TECHNOLOGY – TECHNOLOGICAL PROCESSES
THE THERMOWATT TECHNOLOGY –
PROCESS FLOW DIAGRAM

Completely sealed system: no unpleasant smell or hazardous waste!
EARLIER TECHNOLOGIES OF HEAT RECOVERY

Disadvantages of competing technology:

- More expensive installation
- Less efficient heat transfer
- Existing network must be changed
- High pressure drop - Increased pumping costs
- Smaller energy demands can be serviced
The THERMOWATT Technology – Innovations

- No applications installed inside the sewer
- Larger energy demands can be accommodated for - heating/cooling power gained: 1MW and over!
- Compact size → easier placement
  - Fully underground, deep garage, over ground in a unused building
- Installation in city centres
- Carefully designed devices (screening, heat exchange, heat storage)
  - sufficient for working with wastewater
  - high durability
- System elements are optimised and harmonised
- Specific software developed for easier operation
  - remote supervision (24/7)
  - alarm for system-irregularities
  - several adjustments in the operation of the system can be easily made according to end users’ requirements
ACTIVE REFERENCE PROJECTS AND THEIR OPERATION IN HUNGARY

- **MOM Cultural Centre** (8,600 m², 1 MW)
- **Budapest Sewage Works Premises – Offices & Warehouse** (9,000 m², 1 MW)
- **MH EK Military Hospital** (40,000 m², 600 beds, 3.8 MW)
- **University of Szeged** (25,000 m², 1.4 MW)
- **Budapest Sewage Works Premises – Ferencváros** (16,000 m², 1.2 MW)
1. MOM CULTURAL CENTER – PROJECT TECHNICAL DATA

- Flow of wastewater: 90 m³/h
- Average temperature of wastewater: 15-17°C
- Temperature of return wastewater (heating): 10°C
- Temperature of return wastewater (cooling): 25°C
- Heat Pump capacity in heating mode: 645.8 + 569 = 1214.8 kW
- Heat Pump capacity in cooling mode: 567.4 + 505 = 1072.4 kW
- COP: 6.78-8.24
- Δ T (heating): 35/20°C
- Δ T (cooling): 6/16°C
- Flow of water (heating): 25+25 m³/h
- Flow of water (cooling): 25+13 m³/h
- Power demand (above the demand of heat pump): 43 kW
COMPLETION OF THE IMPLEMENTATION PHASE

- SYSTEM IS IN OPERATION AND UNDER MONITORING SINCE APRIL 2011
2. Budapest Sewage Works – Project Technical Data

- Flow of wastewater: 140 m³/h
- Average temperature of wastewater: 17°C
- Temperature of return wastewater (heating): 10°C
- Temperature of return wastewater (cooling): 25°C
- Heat Pump capacity in **heating mode**: 552 + 540 = 1092 kW
- Heat Pump capacity in **cooling mode**: 557 + 557 = 1114 kW
- Efficiency:
  - EER: 6.92
  - COP: 4.40
- Δ T (heating): 59/45 °C
- Δ T (cooling): 7/12 °C
- Flow of water (heating): 69 m³/h
- Flow of water (cooling): 109 m³/h
- Power demand (above the demand of heat pump): 36 (30) kW
COMPLETION OF THE IMPLEMENTATION PHASE
- SYSTEM IS IN OPERATION AND UNDER MONITORING SINCE NOVEMBER 2012
3. MILITARY HOSPITAL (BUDAPEST) PROJECT TECHNICAL DATA

- Flow of wastewater: 480 m$^3$/h
- Average temperature of wastewater: 17°C
- Temperature of return wastewater (heating): 10°C
- Temperature of return wastewater (cooling): 25°C
- Heat Pump capacity in **heating mode**:
  
- Heat Pump capacity in **cooling mode**:
- Efficiency:
  - COP: 7.38
  - EER: 6.5

- Δ T (heating): 32/22 °C
- Δ T (cooling): 6/12 °C
- Flow of water (heating): 330 m$^3$/h
- Flow of water (cooling): 420 m$^3$/h
- Power demand (above the demand of heat pump): 95 (110) kW
COMPLETION OF THE IMPLEMENTATION PHASE

- SYSTEM IS IN OPERATION AND UNDER MONITORING SINCE JULY 2014
COMPLETION OF THE IMPLEMENTATION PHASE
- SYSTEM IS IN OPERATION AND UNDER MONITORING SINCE JULY 2014
COMPLETION OF THE IMPLEMENTATION PHASE

- SYSTEM IS IN OPERATION AND UNDER MONITORING SINCE JULY 2014
4. UNIVERSITY OF SZEGED
- SYSTEM IS IN OPERATION AND UNDER MONITORING SINCE SEPTEMBER 2015

- Flow of wastewater: 136 m³/h
- Average temperature of wastewater: 17°C
- Temperature of return wastewater (heating): 10°C
- Temperature of return wastewater (cooling): 25°C
- Heat Pump capacity in heating mode: 1559 kW
- Heat Pump capacity in cooling mode: 1204 kW
- Efficiency:
  - COP: 4.76
  - EER: 4.25
- Δ T (heating): 45/30 °C
- Δ T (cooling): 7/13 °C
- Flow of water (heating): 70 m³/h
- Flow of water (cooling): 212 m³/h
- Power demand (above the demand of heat pump): 39 kW
5. **BSW – Ferencvaros**
- System is in operation and under monitoring since November 2015

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow of wastewater:</td>
<td>240 m³/h</td>
</tr>
<tr>
<td>Average temperature of wastewater:</td>
<td>17°C</td>
</tr>
<tr>
<td>Temperature of return wastewater (heating):</td>
<td>10°C</td>
</tr>
<tr>
<td>Temperature of return wastewater (cooling):</td>
<td>25°C</td>
</tr>
<tr>
<td>Heat Pump capacity in <strong>heating mode</strong>:</td>
<td>1232 kW</td>
</tr>
<tr>
<td>Heat Pump capacity in <strong>cooling mode</strong>:</td>
<td>1204 kW</td>
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<tr>
<td>Efficiency:</td>
<td>COP: 3.62 EER: 6</td>
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<tr>
<td>Δ T (heating):</td>
<td>63/50 °C</td>
</tr>
<tr>
<td>Δ T (cooling):</td>
<td>7/12 °C</td>
</tr>
<tr>
<td>Flow of water (heating):</td>
<td>83 m³/h</td>
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<tr>
<td>Flow of water (cooling):</td>
<td>105 m³/h</td>
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<tr>
<td>Power demand (above the demand of heat pump):</td>
<td>58 kW</td>
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</tbody>
</table>
PROJECTS IN PROGRESS

DOMESTIC:

• UNITS OF ST. STEPHAN SQUARE, Budapest (*under construction*)
  • Investor: Municipality
  • Buildings supplied: Market buildings, Mayor’s office, Government offices
  • Project size: 1st phase: 1.7 MW, 2nd phase: extending to a total of 4 MW

• CONGRESS CENTRE, Budapest
  • Project size: 8 MW

• DUNA MEDICAL CENTER
  • Project size: 1st phase: 2 MW, 2nd phase: extending to a total of 4 MW

INTERNATIONAL:

• APA NOVA BUCURESTI – new HQ building (Bucharest, Romania)
  • Investor: Apa Nova
  • Size: 2 MW

• LAKEVIEW WWTP (Ontario, Canada)
  • Investor: Peel Region
  • Size: 4 MW
  • Potential development of a 20 MW district heating system
INVESTMENT IN NUMBERS

IN GENERAL
- **Investment cost:**
  - 1MW ~ 1 million EUR
  - No size limit - investment cost does not increase proportionally
- **Return on investment (ROI):**
  - Retrofitting: 8-10 years \(\rightarrow\) a saving of 120 000 EUR/year
  - New construction: 3-4 years!
- **Savings:**
  - 20-40% saving on energy costs/year for the end user
- **Project financing**
  - Investor: end user, third party investor, ESCO
  - Possible subsidies
- **Annual income (access fee) for the operator (public utility, waterworks, etc.**)
- **Long term operation and maintenance contract**
PROJECT POTENTIAL

POTENTIALS
- Bulgaria (counting with an average overall wastewater production per capita)
  - population: 7.3 million ~ **750 MW**
  - Sofia: 1.2 million ~ **130 MW**

CASE STUDIES – An ideal project
- design phase of the structure, location is in/or near the city centre
- LARGE buildings: high and continuous energy need
  - Hospital, Hotel, Shopping Mall, Data centre, Industrial Park, WWTP, etc.
- continuous cooling and/or heating requirement, or both simultaneously
## Retrofittng vs. New Construction

<table>
<thead>
<tr>
<th></th>
<th>Heating and Cooling with Thermowatt Technology</th>
<th>Heating and Cooling with Standard Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Pump/Liquid Chiller</td>
<td>€120,000</td>
<td>€120,000</td>
</tr>
<tr>
<td>General mechanical and electrical installation</td>
<td>€450,000</td>
<td>€450,000</td>
</tr>
<tr>
<td>Heating boiler with chimney</td>
<td>----</td>
<td>€65,000</td>
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<tr>
<td>Waste water management machinery</td>
<td>€72,000</td>
<td>----</td>
</tr>
<tr>
<td>Waste water - primary water heat exchanger battery</td>
<td>€110,000</td>
<td>----</td>
</tr>
<tr>
<td>Thermowatt specific mechanical and electrical installation</td>
<td>€250,000</td>
<td>----</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>€1,002,000</td>
<td>€635,000</td>
</tr>
<tr>
<td>Extra cost for Thermowatt technology for new facilities</td>
<td>€367,000</td>
<td>----</td>
</tr>
</tbody>
</table>
ECONOMIC ADVANTAGES — LONG TERM SUSTAINABILITY

- The heating and cooling costs of a building are significantly lower and energy savings are guaranteed because of the energy efficiency (COP) of this system.
- Energy Directives require increasing usage of renewable energy sources, which makes operating a wastewater based system much more favourable.
- In the case of rental properties its “Green” character would make selling and/or long term renting, leasing more favourable.
- The PR value provides a more competitive position.
- Long term agreements with the main operators of the sewage network.
CO-OPERATION

EXPECTATIONS:
- Demonstrate a great technology solution, inspire “sponsors” for the Technology
- Looking for partnership and cooperation as well as potential customer, investor
- Learn local market specifications and ways of doing business and developing projects

NEXT STEPS:
- Locating possible project sites - cooperation in project-quest
- Organizing initial meetings, technical assistance for preliminary studies
- Recruiting suitable constructor/operator companies
- Attracting capital for investments (possible subsidies), signing agreements on project implementation

FUTURE:
- PROJECTS, PROJECTS, PROJECTS
THANK YOU FOR YOUR ATTENTION!

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