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CleanTech Alliance™

Wastewater Energy Transfer

THE BENEFITS AND USES OF WET SYSTEMS

LINDSAY MCCORMICK

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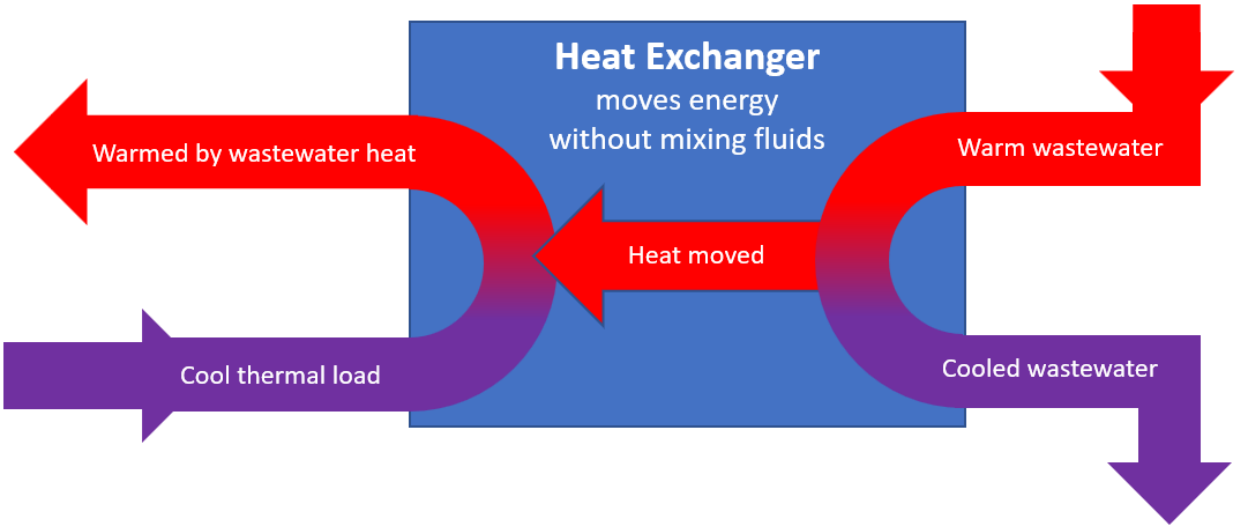
What is Wastewater Energy Transfer?

Wastewater Energy Transfer (WET) refers to a thermal energy exchange between a thermal load and the municipal wastewater system, where the load (e.g. a building or a district energy system) can take heat from, and/or reject heat (cooling) to the municipal wastewater system. This exchange can occur in-building, with the trunk sewer network, and at wastewater treatment plants.

How Does it Work?



Simply put, a WET system is installed where wastewater exits, extracting & transferring heat to/from wastewater to supplement your heating & cooling needs. By pre-heating the water fed to your hot water tank/boiler, it doesn't have to work as hard to heat the water and a tremendous amount of energy, money & GHG is saved.

In a WET system, an intake structure is connected to a sewer main, and a portion of the flow is pumped to an above-ground heat exchanger. A heat exchanger extracts heat energy from the wastewater. In the heat exchanger, heat energy is transferred to water or another clean carrier medium. The carrier medium transports the energy to a heat pump, which is used for maintaining proper temperature in the building. The cooled or heated wastewater then flows back to the sewer.

Scale

The scale of Wastewater Energy Transfer systems can range from a single building to campus-scale energy solutions. Varying sizes of scale requires different types of systems.

At SHARC Energy, for example, they use their SHARC series systems for bigger projects like District Energy, Large Commercial & Industrial use, and their smaller PIRANA systems for apartment complexes, hotels, and commercial use.

For HUBER Technologies' system, a continuous wastewater flow of at least 1.3 gallons per second (5 liters per second) is required to ensure efficient heat recovery and the wastewater temperature should not fall below 50°F or 10°C (HUBER Technologies, 2022).

According to King County, any building type or size can be considered for their Sewer Heat Recovery program. “Potential Users should conduct a needs analysis, assess their building’s heating and cooling system(s), and evaluate the costs associated with building and operating a SHR system in order to determine whether it is a good fit.

King County relies on Users to do their own assessment and make their own decision. In general, a greater demand for heating and cooling is a better fit due to the cost to build the system and economies of scale” (King County, 2020).

In general, the bigger the scale and the more wastewater going down the drain, the bigger potential for heat recovery and energy savings.

Benefits of WET Systems

Cost Savings

One of the most attractive benefits of a Wastewater Energy Transfer system for building owners is the cost savings potential.

According to HUBER Technologies, “recycling heat energy from wastewater saves costs. Energy costs for heating and cooling can be reduced by up to 80% when compared with conventional methods.”

According to a white paper analysis conducted in King County, Washington on behalf of SHARC Energy Systems, the implementation of a wastewater energy transfer system can reduce energy costs in office buildings by 29% and in mixed-use buildings by 45%.

The study estimated an annual energy and operation cost savings of $19,891 for office buildings that adopt a WET system and $44,239 for mixed-use buildings.

Additionally, the study found that in King County, the estimated annual thermal energy charges drop from $3,159 to $2,782 in office buildings with the use of an internal energy recovery system, and from $4,102 to $2,522 in mixed-use buildings with the same system.

In sum, the average reduction in HVAC and Domestic Hot Water energy costs to the building owners in the range of 29 to 45%, while generating (conservatively) $2,500 to $4,000 per application in annual Thermal Energy Charges to the wastewater authority. Placed into the context of annual Thermal Charge Revenue per ton of the peak cooling load; the Office was approximately $6 to $7 per ton and the Mixed Use was approximately $5.50 to $9 per ton.

Table 1

PROJECT INFORMATION		
	OFFICE	MIXED-USE
Building Area	130,000 SF	185,000 SF
Building Location	Seattle, WA	Seattle, WA
Peak Cooling Load (tons)	457 tons	457 tons
Peak Heating and DHW Load (1,000 BTU per hour)	3,120 MBH	4,218 MBH
Estimated number of building occupants	650	555
Electric Rate: (kilowatt hour)	$0.0990/kWH	$0.0990/kWH
Natural Gas Cost: (million BTU)	$8.99/MMBTU	$8.99/MMBTU
Water Cost: (per 100 cubic feet)	$6.86/CCF	$6.86/CCF
Wastewater Cost: (per 100 cubic feet)	$6.00	$6.00
Cooling Tower Chemical Treatment: (per million BTU)	$0.71	$0.71
Thermal Energy Charge: (ton-hour)	$0.005/T-H	$0.005/T-H
Thermal Energy Charge: (million BTU)	$0.417/MMBTU	$0.417/MMBTU
ESTIMATED ANNUAL ENERGY & OPERATION COST		
	OFFICE	MIXED-USE
Boiler/Chiller/DHW – No Wastewater Energy Recovery	$69,556	$98,821
HR Chiller & SHARC Wastewater Energy Recovery	$49,666	$54,582
Est. Annual Energy Cost Reduction	$19,891 (-29%)	$44,239 (-45%)
Boiler/Chiller/DHW – No Wastewater Energy Recovery	$0.58/SF	$0.82/SF
HR Chiller & SHARC Wastewater Energy Recovery	$0.41/SF	$0.45/SF
ESTIMATED ANNUAL THERMAL ENERGY CHARGE		
	OFFICE	MIXED-USE
With internal energy recovery system (6 pipe HR Chiller)	$2,782	$2,522
Without internal energy recovery system	$3,159	$4,102

Reduced Carbon Footprint

In addition to saving businesses money, WET systems can lower a building's carbon footprint and help climate goals around emissions and energy efficiency.

Using a wastewater heat exchanger reduces the use of fossil fuels. This improves the environment by reducing emissions and lowering a building's carbon footprint. The supply of wastewater is virtually unlimited, and wastewater is a free, local, and decentralized heat source. There is little interference to the existing sewer system, and minimal construction required to access the wastewater.

In the same white paper conducted in King County, it found that CO2 emissions were reduced in both office and mixed-use buildings that implemented SHARC's wastewater energy transfer system.
The office building went from 155 to 102 tons of annual CO2 emissions after implementation and the mixed-use space went from 391 to 112 tons, a whopping 279-ton difference!

In total, the office building saw an estimated annual CO2 emission reduction of 34% and the mixed-use building saw a 71% emission reduction.

Table 2

ESTIMATED IMPACT ON ANNUAL EMISSIONS (metric tons)		
	OFFICE	MIXED-USE
Boiler/Chiller/DHW – No Wastewater Energy Recovery	155 tons	391 tons
HR Chiller & SHARC Wastewater Energy Recovery	102 tons	112 tons
Est. Annual CO2 Emission Reduction	53 tons (-34%)	279 tons (-71%)

Since Washington state already has some of the cleanest electricity in the country due to abundant hydropower, it stands to reason that the implementation of WET systems in states whose energy mix is comprised more heavily of fossil fuels could see an even deeper reduction in emissions.

According to a report out of Toronto, Canada, Toronto's sanitary trunk sewer network is estimated to have the capacity to potentially support over twenty WET projects. Once in operation, these projects would reduce approximately 200,000 tons of GHG emissions annually while unlocking value for the City through the sale of thermal energy.

King County agrees that implementing WET systems is a way to harness wasted heat as a new, renewable energy source with no new carbon emissions. Wastewater heat recovery is a step toward protecting the environment to combat climate change, and can help businesses establish green, and leverage sales and occupancy engagement strategies by promoting sustainable practices that attract to tenants, buyers, and potential investors.

Reduced Water Usage

One of the often-overlooked benefits of Wastewater Energy Transfer is the potential for dramatically reducing a building's water usage.

SHARC Energy's WET system minimizes water usage by reducing the use of freshwater in cooling towers and reducing the ambient temperature of wastewater to acceptable levels for treatment and discharge

According to the white paper commissioned by SHARC Energy, in King County, the average office building uses an estimated 985,266 gallons of fresh water per year on their boiler, chiller, and domestic hot water. Comparatively, a mixed-use building uses an estimated 743,021 gallons of water per year. The implementation of SHARC's WET system and HR chiller brings both those numbers to 0 gallons of water, an estimated annual water consumption reduction of 1,728,287 gallons of water in just the two buildings studied.

Table 3

ANNUAL COOLING TOWER WATER CONSUMPTION (gallons)		
	OFFICE	MIXED-USE
Boiler/Chiller/DHW – No Wastewater Energy Recovery	985,266 gallons	743,021 gallons
HR Chiller & SHARC Wastewater Energy Recovery	0 gallons	0 gallons
Est. Annual Water Consumption Reduction	985,266 gallons	743,021 gallons

Reducing freshwater consumption is only going to become more important in the coming years as climate change continues to increase the frequency and intensity of droughts, resulting in water scarcity in places such as the southwest United States.

Frees up Roof Space & Reduces Pollution

One final benefit of implementing a WET system for cooling is the elimination of bulky and noisy cooling towers on top of buildings. This frees up roof space for a myriad of things from adding solar panels to planting a rooftop garden with carbon-sequestering plants.

In addition to more roof space, WET systems also eliminate both the noise pollution from cooling towers and the cleaning chemicals that cooling towers use that pollute the water.

While the cooling tower itself doesn't release any emissions other than water vapor, chemicals such as chlorine dioxide and hydrochloric acid which are used to clean the cooling tower water and ensure it's free of bacteria and limescale can have negative impacts on the environment.

All of the issues associated with cooling tower units on large commercial and mixed-use buildings can be avoided through the implementation of Wastewater Energy Transfer systems.

Conclusions

The benefits of installing Wastewater Energy Transfer systems are clear. From saving money to reducing emissions and water usage to freeing up roof space and more, utilizing WET systems makes both economic and environmental sense.

WET systems can be installed just about anywhere that is connected to the sewer line, but they have the greatest energy savings potential when installed on sewer lines with the greatest volume of water flow and available heat. King County in Washington state put together an interactive map of the King County sewer system that shows where the implementation of WET systems could reclaim the most heat and lead to reduced energy usage and cost savings for building owners.

By using maps and other tools like this, municipalities can help to educate building owners about the numerous benefits of WET systems and prioritize installation in locations that can do the most good for the climate.

Additionally, state governments can encourage WET system adoption by changing the state definition of clean energy to include waste heat reclamation so that buildings that install WET systems are eligible for tax breaks and renewable energy credits or RECs associated with clean energy adoption.

Washington, DC has already changed their laws to include “wastewater as a heat source or sink for a heating or cooling system.” If other states and cities do likewise, WET systems will become more prevalent around the country and lead to more communities gaining from the benefits.

Wastewater Energy Transfer systems are a powerful tool in the fight against climate change and we’re going to need to use every tool in the toolbox to ensure we have a healthy and habitable planet for generations to come.