How to integrate
WASTE WATER HEAT RECOVERY SYSTEMS WWHR
sustainably and cost-efficiently

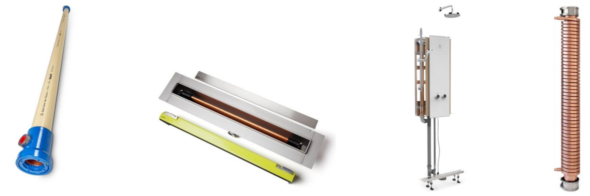
Context

WWHR can utilize the otherwise lost heat for water heating, especially for the shower, which accounts for about 70 to 82 % of the daily residential hot water tapping profile. [1,2]

The unique advantage of WWHR, is achieving high thermal energy savings without compromising on user comfort with low material and monetary needs. Beside a smaller hot water storage volume, the WWHR decreases the required power of flow heaters.

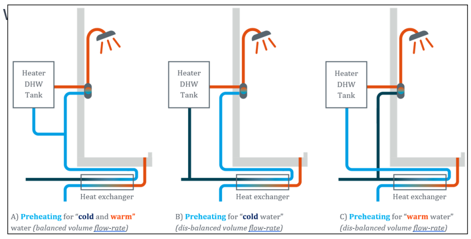
State of the art

Most widespread types of heat exchangers are screed embedded **horizontally installed shower drains (2)** or **vertically installed pipes (1)**, which benefit from "no maintenance" at lower prices compared to the horizontal ones. However, the space and access required to the floor below can cause difficulties with retrofits. So-called **active heat recovery systems (3)** pump the shower wastewater into a vertical heat exchanger that can be installed on the shower level. These systems can be also equipped with a primary heat source e.g. an electrical water heater. The **centrally installed heat-exchangers (4)** may be able to also utilize the waste heat from a not-simultaneous application, for example a bathtub, washing-machine, etc.

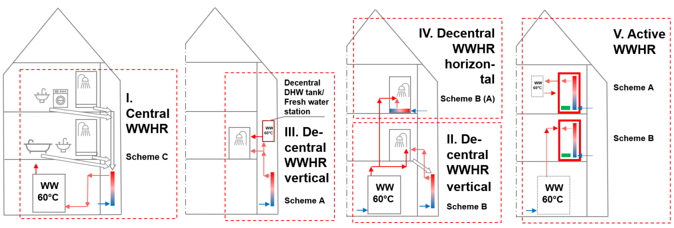


Waste-water heat exchanger for vertical (1), horizontal (2) application; active heat exchanger (3); central heat exchanger (4); source: Counter Flow Products B.V., Joulia ltd., Hamwells Nederland B.V., RenewABILITY Energy Inc.

Efficient energy transfer in the heat exchanger requires a balanced volume flow rate of fresh and wastewater. **Connecting preheated water to both the shower mixer and water heater (A)** may increase installation complexity but delivers the highest possible efficiency. Alternatively, if the preheated water only feeds the shower mixer (B.) or the DHW heater (C), the efficiency will drop depending on domestic hot



Hydraulic connection possibilities of a WWHR device

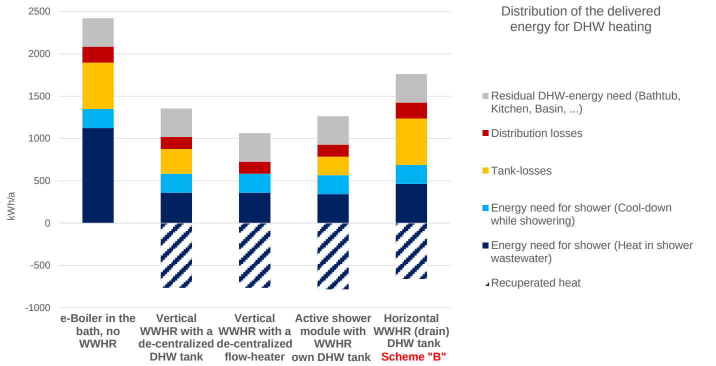


Placement of WWHR	Use	Scheme	Wastewater from	Wastewater
I. Central WWHR	**New-construction, or retrofit; Centralised per building, preheated cold water for a storage**	„C" central heater	all flats	gray, eventually black (Φ min 90mm)
II. Decentralized vertical	**New construction or core renovation, decentralised / central heater available**	„B" only mixer	shower, eventually a bath	gray, eventually black (Φ min 90mm)
III. Decentralized vertical	**New construction or core renovation, central heater combined with fresh-water station**	„A" mixer and heater	shower, eventually a bath	gray, eventually black (Φ min 90mm)
IV. Decentralized horizontal	**(Re)construction of a single bath, Heat from the central DHW system transferred via fresh-water**	„B" only mixer „A" if decentralized heater	shower	gray
V. Active	**Renovation of a single bath, Heat from the central DHW system or decentral heater**	„B" „A" if decentralized heater	shower	gray

The WWHR units can be installed in many different ways, especially if they are integrated into a centralised or decentralised hot water system. To achieve an optimal design, there are also other aspects that influence the planning, such as the type of grey water, the placement of the WWHR unit, maintenance, etc.

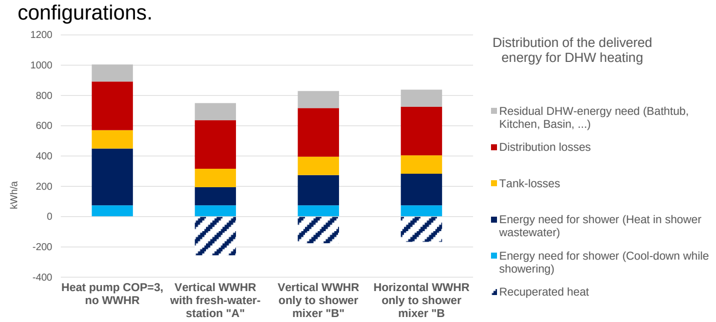
Decentralied DHW system

In this benchmark calculation [3], several decentralized DHW systems installed directly in the bathroom with or without WWHR are compared in a full distribution of the delivered energy (direct electrical power).



Centralied DHW system

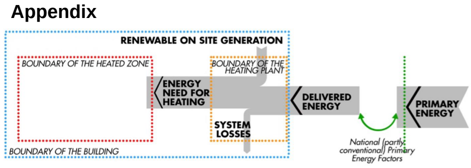
In this benchmark calculation [3], a full distribution of delivered energy (direct electrical power) is shown, while a centralised hot water system driven by a heat pump operating at COP=3 is combined with different WWHR configurations.



Conclusion

The savings on delivered energy for water heating can be up to 40 %.
WWHR can only cover a portion of the delivered energy (energy requirement for showering), which reaches the WWHR device via the drain. The significantly larger proportion goes for example the thermal losses, which on average account for around 1/3 in decentralised hot water systems and up to 1/2 in centralised systems can not be covered.
If a centralised DHW system powered by a heat pump combined with WWHR cannot be used, a minimalist decentralised DHW system with WWHR can be an alternative despite the use of direct electricity. In this case, scheme A is easier to achieve and the thermal losses are reduced to a minimum. However, the accumulation of renewable energies is less feasible in this constellation.

Appendix



Methodological explanatory to the EPBD; Explanatory note from eceee regarding the EPBD draft Annex I; European Council for an Energy Efficient Economy; 1 December 2017

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1: Anna Marszal-Pomianowska et. al; Comfort of Domestic Water in Residential Buildings: Flow, Temperature and Energy in Draw-Off Points: Field Study in Two Danish Detached Houses; Energies 2021
2: Bertrand et. al ; Characterization of domestic hot water end-uses for integrated urban thermal energy assessment and optimization; Applied Energy 2017
3: 2.3-person household (EU average); shower 6 times a week; 9 l/min; 6 min at 40 °C; average cold-water temperature 10 °C; 80% of the total hot water requirement is for the shower